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OPERATION & MAINTENANCE HANDBOOK

MODEL P906 PLUG-IN OUTPUT UNIT

Part Number 37000-268

INSTRUMENT REGISTRY

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MP MASTER



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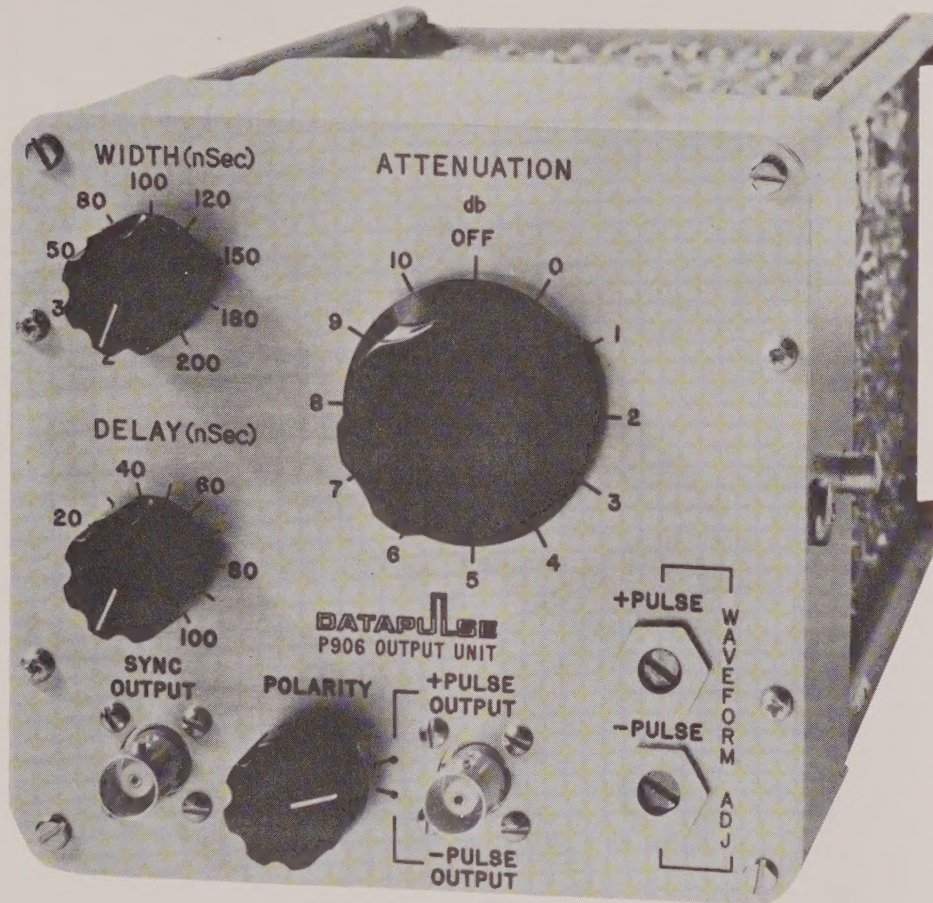
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MODEL P906 PLUG-IN OUTPUT UNIT

The P906 Plug-In Output Amplifier is designed for use with Datapulse Models 103M Pulse Generator and 200M Series Data Generator. The P906 features positive or negative pulse outputs at sub-nanosecond rise times (typically 0.8 nanosec) and very narrow pulse widths (2 to 200 nanosec). In addition to the Main Pulse Output, the P906 also supplies a Sync Output for triggering oscilloscopes and other external equipment.

This manual provides detailed instructions for the use and maintenance of your Model P906. A thorough understanding of the contents will contribute to full utilization and longer life of this unit.

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SECTION I

SPECIFICATIONS

MODEL P906

1.1 GENERAL DESCRIPTION

The P906 Plug-In Output Amplifier is designed for use with the Datapulse Model 103 Pulse Generator, Model 200M Word Generator, and Model 202M Data Generator. The ability to generate positive or negative pulses with transition times of less than 1 nanosec (10^{-9} sec), is the main feature of the P906. Maximum amplitude of the pulse output is 10v into 50 ohms; pulse output duration is continuously variable from less than 2 nanosec to 200 nanosec. In addition to the main pulse output, the P906 also supplies a sync output for triggering oscilloscopes and other external equipment. Delay between the main pulse output and the sync output is -10 nanosec (pulse advance) to +100 nanosec (pulse delay). Longer pulse delays can be obtained by using the Model 103 Reference Sync Output for external triggering. Main pulse output amplitude is controlled by a 0-10 db attenuator with 1 db steps; polarity is controlled by a 2-position, front panel switch. All triggering signals and operating voltages are derived from the Models 103, 200M, or 202M.

1.2 APPLICATIONS

The P906 is designed for applications in which pulses of sub-nanosecond transition time are required. The ability to generate fast rise time pulses of narrow width and large amplitude, makes the P906 ideal for both research and development and production line testing. The fast rise time capability is particularly useful for measuring the switching time of diodes, transistors, magnetic cores, thin film devices, cryogenic devices, and vacuum tubes, and for testing the step response of active circuits and transmission line characteristics. The P906 output can be used to detect and measure inductance of nanohenry size and capacitance of picofarad size, such as found in diodes and transistors. The same technique can be used also to measure the shunt capacitance of inductors and the series inductance of capacitors.

1.3 INPUT TRIGGER

(As provided by standard Models 103, 200M, and 202M). Negative 2v pulse from 100 ohm source, 10 nanosec rise time, 20 nanosec width.

1.4 REPETITION RATE

Zero to 1 Mc as provided by instrument with which used. Inputs above 1 Mc are counted down within the unit to prevent damage to output circuitry.

1.5 PULSE OUTPUT

Positive or negative, selectable by polarity switch, dc coupled with baseline at ground.

1.5.1 Delay

Leading edge of the pulse output occurs at a fixed delay, approximately 130 nanosec from the input trigger.

1.5.2 Pulse Width

Continuously variable from 2 to 200 nanosec.

1.5.3 Amplitude

10v into 50 ohms, with 0 to 10 db attenuation provided in 1 db steps (attenuator accuracy approximately $\pm 1\%$). Maximum amplitude drops to 8v when pulse duration is less than 25 nanosec.

1.5.4 Transition Times (With Properly Connected 50 Ω Load)

Rise time is typically 0.8 nanosec (1 nanosec maximum); fall time is typically 0.9 nanosec (1.1 nanosec maximum).

1.5.5 Waveform Aberrations (With Properly Connected 50 Ω Load)

Overshoot, undershoot, ring, and top slope are less than 5%. Screwdriver adjustments on front panel are provided for trimming waveform of each polarity.

1.6 SYNC OUTPUT

Provided as a variable position reference for the pulse output.

1.6.1 Delay of Pulse Output from Sync Output

Continuously variable from 10 nanosec advance to 100 nanosec delay; i.e., sync is delayed approximately 30 to 140 nanosec from input trigger to the unit.

1.6.2 Sync Pulse Characteristics

Positive 4v into 100 ohms (2v into 50 ohms), approximately 50 nanosec duration; rise and fall times approximately 10 nanosec (with 100 ohms or less load).

1.7 POWER REQUIRED

± 23 v dc as provided by Datapulse Models 103, 200M, or 202M.

1.8 PHYSICAL

Aluminum panel with etched black and red markings. Plugs into space provided in standard Datapulse instruments, mating with 24 contact Blue Ribbon connector. Front panel signal connectors are BNC type. Size is 4-3/8"H x 4-3/4"W x 8-1/2"D. Weight is approximately 3-1/2 lbs.

1.9 ACCESSORIES

Furnished with one operation and maintenance manual section for insertion in basic instrument manual. Other accessories available at additional cost include extra manuals, coaxial cables, connector adapters, and Type 2002A, 15 watt, 50 ohm load, and the Type 2302 Mixer Unit.



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OPERATING INSTRUCTIONS

2.1 DESCRIPTION OF CONTROLS AND CONNECTORS

2.1.1 Width Control

This control varies the main output duration from less than 2 nanosec to over 200 nanosec. The control is calibrated to an accuracy of approximately $\pm 10\%$ when the duration is greater than 50 nanosec.

2.1.2 Delay Control

This control varies the time relationship between the sync output and the main output. With the control in the maximum counterclockwise position, the main output occurs 10 nanosec before the sync output. Turning the control clockwise increases the main output delay with respect to the sync output. The delay range is -10 nanosec to +100 nanosec; front panel calibration is nominally accurate to $\pm 10\%$.

2.1.3 Polarity Control

This control varies the main output polarity. The control may be operated with the power on and the main output loaded without damaging the P906.

2.1.4 Attenuation Control

This control varies the main pulse output amplitude. The control provides maximum 10 db attenuation in steps of 1 db each. The attenuator accuracy is better than $\pm 1\%$ when the external load is 50 Ω .

2.2 PLACING IN OPERATION

Set the Repetition Rate Control of the parent pulse generator to approximately 100 kc. Plug the P906 into the Channel A slot of the pulse generator. Set the pulse generator Delay Control (there is no Delay Control on the 200M) to the minimum position. Set the P906 Width and Delay Controls to approximately 50 nanosec. Turn the P906 Polarity Control to the + Pulse position; Attenuation Control to 0 db. Connect the main output of the P906 to a sampling oscilloscope, such as the Tektronix Model 661 or equivalent. Make certain that the connecting cable has the necessary bandwidth to pass pulses of less than 1 nanosec rise time. The load end of the connecting cable must be terminated in a good 50 Ω load. If the sampling oscilloscope is the direct input type, such as the Tektronix Model 661 with the Model 451 Plug-In, no additional load is needed because the input impedance of the scope is 50 Ω . If the sampling scope is the type in which the sampling bridge is in the probes, such as the Hewlett-Packard Model 185 with the Model 187 Plug-In, the P906 output should be connect as shown in Figure 2-1.

Turn on the pulse generator power switch. A positive pulse of 10v amplitude and 50 nanosec duration should appear on the oscilloscope face. Check the rise and fall times of the pulse (measured between the 10% and 90% amplitude points) for less than 1 nanosec. The waveform should resemble those shown in Figure 2-2. Although pulse aberrations may differ from those shown, the magnitude of aberrations should be less than 5% of the pulse amplitude. Vary the Width Control over its full range;

the pulse duration should change from less than 2 to over 200 nanosec. Check the Attenuation Control by noting the decrease in pulse amplitude for each step of attenuation; the amplitude should decrease by approximately .11% for each step.

Set the Polarity Control to the - Pulse position. With the attenuator set at 0 db and the Width Control at 50 nanosec, the pulse should appear as shown in Figure 2-3. Check the rise and fall times for less than 1 nanosec. The Width Control should vary the pulse duration from less than 2 to over 200 nanosec. Check the Attenuation Control for 11% decrease in pulse amplitude for each step of attenuation. Pulse aberrations should be less than 5%.

The delay between the main output and the sync output may be checked by triggering the oscilloscope with the reference sync output of the pulse generator. The P906 sync output should be fed into Channel A of the oscilloscope and the main output should be fed into Channel B. Varying the Delay Control over its full range should vary the delay between the sync output and the main output from -10 nanosec to +100 nanosec. The sync output should appear as shown in Figure 2-4 when properly terminated into 50 Ω .

2.3 OPERATING CONSIDERATIONS

2.3.1 Frequency Limitations

The maximum operating frequency of the P906 is limited by the lifetime of the "snap off" diodes and by the maximum allowable dissipation of the output drivers. For this reason, the P906 has a built-in divider circuit which automatically limits all input signals to less than 2 Mc.

At frequencies above 500 kc, the pulse shape changes as shown in Figure 2-5. This condition can be corrected by adjusting the Waveform Adj Controls on the front panel of the P906. The + Pulse Waveform Control should be adjusted for maximum flat top on the positive pulse output. The - Pulse Waveform Control should be adjusted for maximum flat top on the negative pulse output.

2.3.2 Duty Cycle Limitations

Because the maximum input frequency is automatically limited by a divider circuit, there is no duty cycle limitation on the P906. The unit can be operated at any control setting without adverse effects.

2.3.3 Output Characteristics

2.3.3.1 Amplitude Control: The P906 output is coupled to the BNC connector by a constant impedance, wideband attenuator. The attenuator provides 10 db attenuation in 1 db steps. If further attenuation is required, external attenuators, such as General Radio Coaxial 10 db Attenuator, No. 174-620, can be used. By cascading these attenuators, clean pulses down to 5 mv can be obtained from the P906. Figures 2-6A and 2-6B show the P906 output attenuated by the internal attenuator and by four external attenuators.

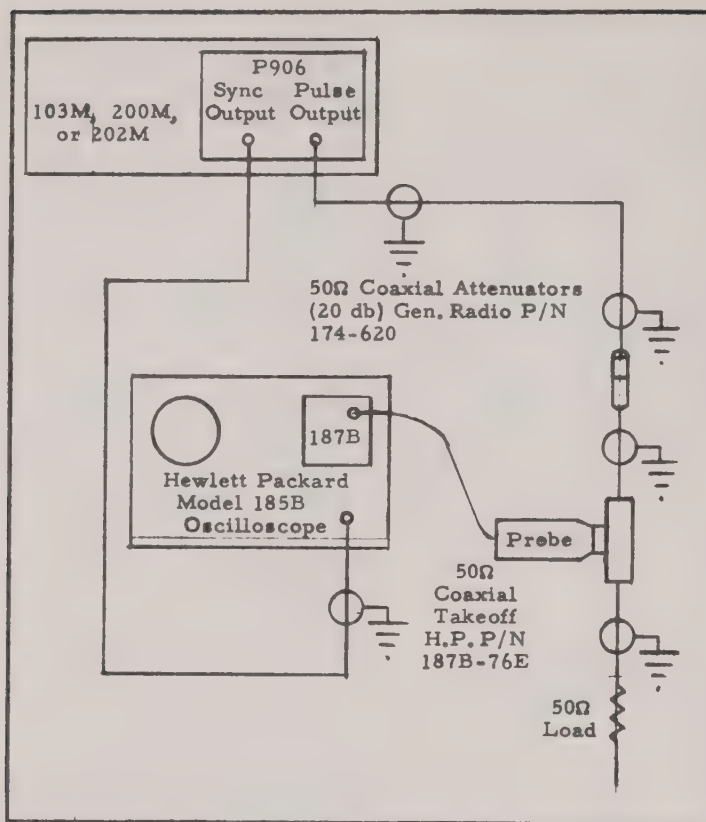


Figure 2-1. Scope Interconnections for Waveform Verification

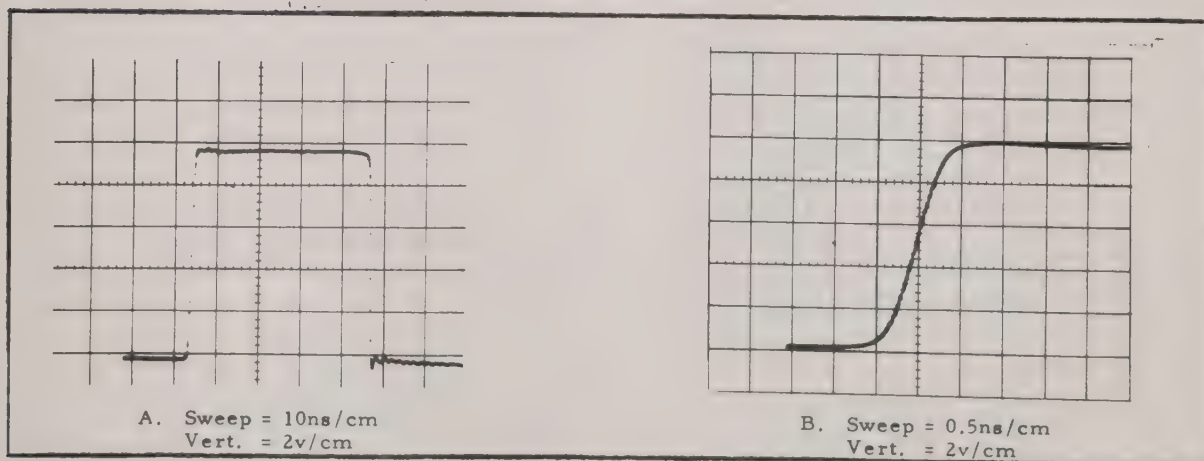


Figure 2-2. Positive Output Properly Loaded into 50Ω.
Photographed from Tektronics Model 661
Sampling Oscilloscope

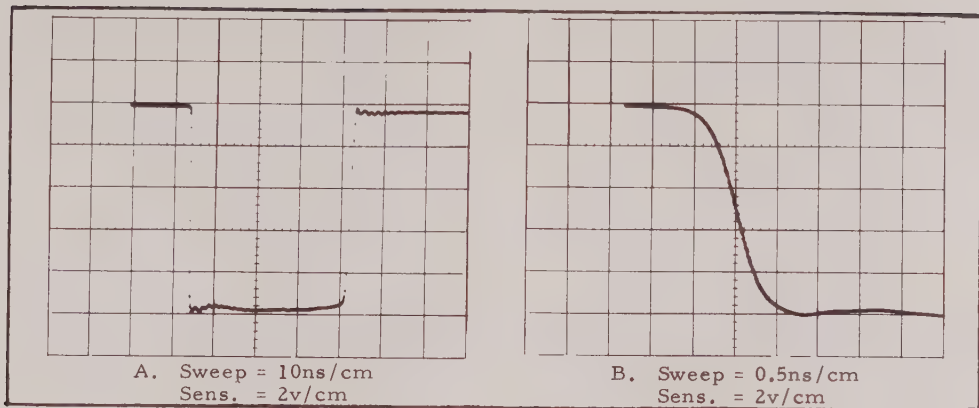


Figure 2-3. Negative Output Properly Terminated into 50Ω .
Photographed from Tektronix 661 Sampling Scope.

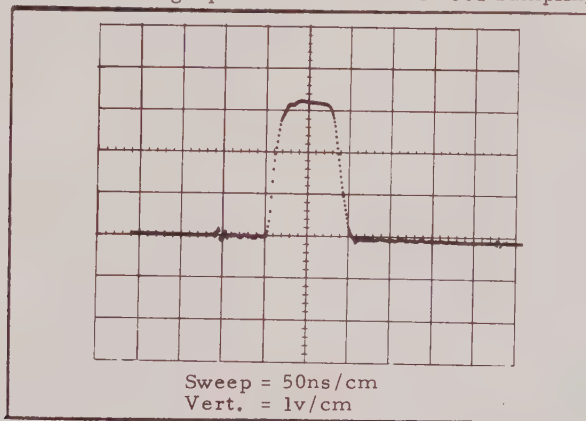


Figure 2-4. Sync Output Pulse Properly Terminated into 50Ω .
Photographed from Tektronix 661 Sampling Scope.

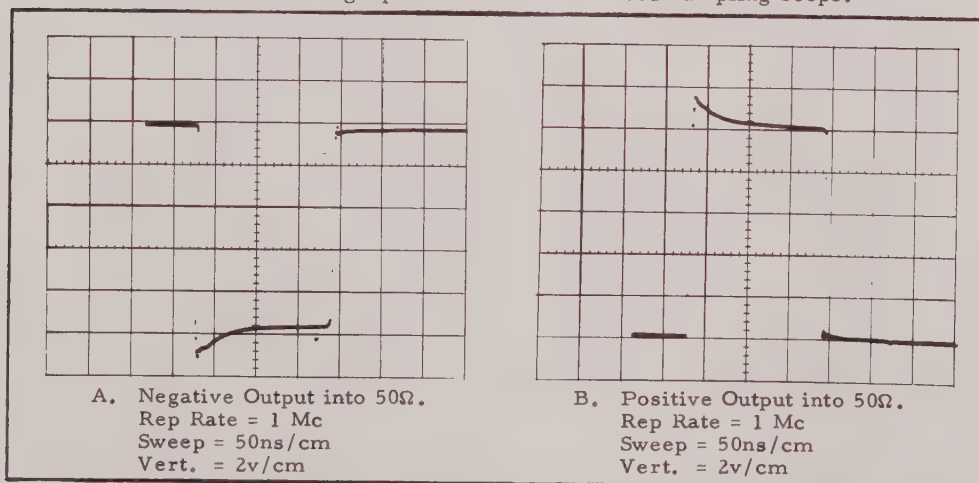


Figure 2-5. Effect of Frequency on Pulse Shape above 200 kc.

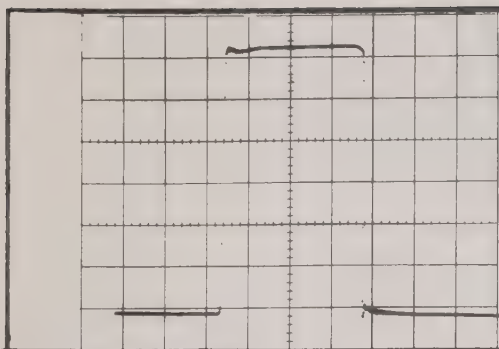


Figure 2-6A. P906 Output with Attenuator Control
Set for 10 db. Sweep = 20ns/cm
Vert. = 0.5v/cm

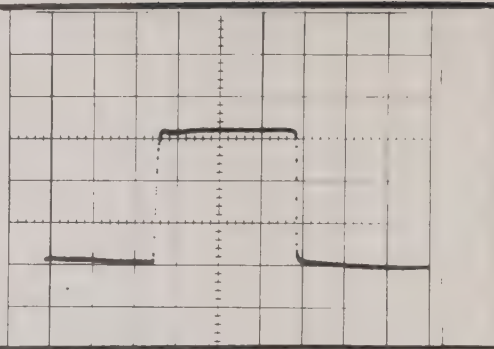


Figure 2-6B. P906 Output with Attenuator Control
Set for 10 db in Cascade with 4 Gen.
Radio 174-620 Attenuators (40 db).
Sweep = 20ns/cm, Vert. = 0.1v/cm

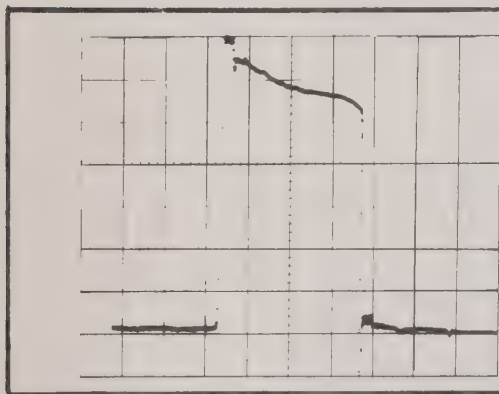


Figure 2-7A. P906 Output Loaded into 100Ω
Directly at BNC Connector.
Sweep = 20ns/cm
Vert. = 2v/cm

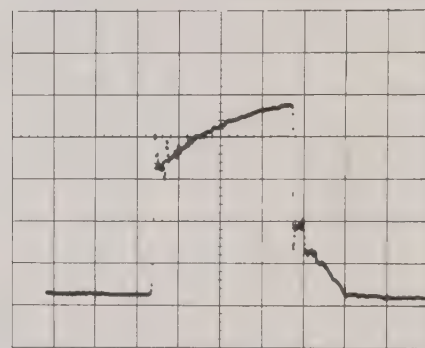


Figure 2-7B. P906 Output Loaded into 22Ω
Directly at BNC Connector.
Sweep = 20ns/cm
Vert. = 2v/cm

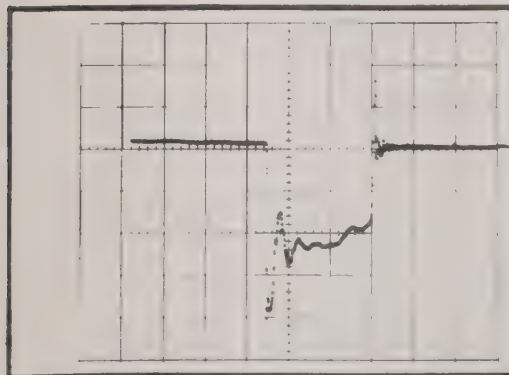


Figure 2-8A. P906 Open Circuited. Attenuator Set
at 0 db Position. Sweep = 50ns/cm
Vert. = 5v/cm

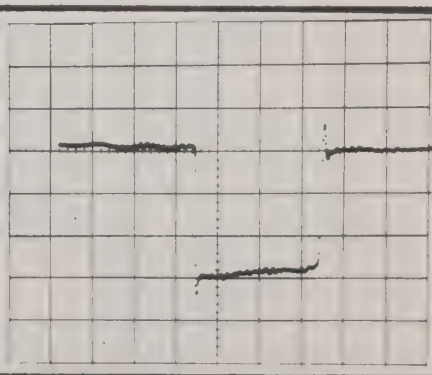


Figure 2-8B. P906 Open Circuited. Attenuator Set
at 10 db Position. Sweep = 50ns/cm
Vert. = 2v/cm

2.3.4 Loading Considerations

One of the major advantages of the P906 is the ability to generate clean waveforms at less than 1 nanosec rise and fall times. To preserve this degree of pulse fidelity, it is imperative that consideration be given to loading. The generation of clean waveforms with fast rise and fall times requires state-of-the-art circuit design and packaging techniques. Therefore, it is necessary to restrict the type of loading which can be imposed. Because of the wide industrial use of 50 ohm coaxial cables and accessories, the P906 was designed to operate with a 50 ohm load; however, it can be terminated with other than a 50 ohm load at the expense of poor wave-shape, without damage. Figure 2-7A shows the unit terminated into 100Ω; Figure 2-7B shows the unit terminated into 22Ω. Both photos were taken with the load placed directly across the output BNC connector. The monitoring probe used was the Tektronics P6032 Cathode Follower. Note that in both instances, the resulting waveform was considerably deformed.

2.3.5 Cabling Considerations

For most applications, the P906 will be used to energize circuits which are physically removed by several feet. In this case, it will be necessary to transport the signal by means of a 50Ω transmission line. Preservation of low distortion waveforms is largely contingent upon both the method of cabling and proper line termination. Clean waveforms are maintained by connecting the generator to its load with 50Ω coaxial cable and terminating the cable at the receiving end into 50Ω. This is true also of the sync connection to the oscilloscope. The termination lead length must be kept to a minimum at the receiving end of the coaxial cable in order to minimize pulse aberrations. Figure 2-9 shows the effect of a 50Ω coaxial cable terminated into 50Ω through 4 inches of wire. Note the slower rise time and the reflections caused by the mismatch. Figure 2-10 shows the effect of using a 93Ω cable with a 50Ω termination. Figure 2-11 shows the effect of terminating a 50Ω coaxial cable with a 100Ω load.

2.3.6 Obtaining Outputs Higher than 10v with Coaxial Cables

Because the P906 can generate narrow pulses of fast rise and fall times, it is feasible to use open circuited, 50Ω coaxial cables as step-up transformers. If the P906 drives a coaxial cable with a delay time greater than 1/2 the pulse width and the receiving end is open circuited, the resulting waveform at the receiving end will be twice the amplitude of the waveform at the sending end. The waveform fidelity at the receiving end will depend upon the quality of coaxial line used and upon the type of loading at the receiving end. Figure 2-12 illustrates the waveform at the receiving end of 6 ft. of 50Ω coaxial cable terminated in an extremely high impedance (the input impedance of the Tektronics P6032 Cathode Follower Probe). Note that the amplitude is approximately 20v and that the waveshape is fairly clean.

The length of coaxial cable required for a given pulse width is determined by the propagation velocity of the line itself. The line must be greater than:

$$L = \frac{\text{Pulse Width}}{2 \times \text{Propagation Velocity}}$$

For RG58/U coaxial cable, the physical length of the line is given by:

$$L = \frac{\text{Pulse Width}}{3}$$

where Pulse Width = Nanoseconds, and L = Feet

If the length of the line is less than that required, there will be severe pulse distortion. This effect is shown in Figure 2-13 in which the electrical length of the line is insufficient to support the pulse width.

2.3.7 Non-Linear Loads

In many cases, the unit will be used to drive non-linear loads such as transistors and diodes. This type of loading generally exhibits high impedance in one direction and low impedance in the opposite direction. To obtain clean waveforms, care must be taken to insure uniform loading on the unit in both directions. Figure 2-14 illustrates some methods of terminating the unit when driving into the base of a transistor. The same techniques apply when driving diodes since the base of a transistor resembles a diode.

The external connections shown in a, b, and c of Figure 2-14, are suggested for driving into transistor stages. In these examples, the "speed up" capacitor will slow the rise and fall times of the main pulse output. Ringing may occur if the transistor load improperly terminates the generator. These examples illustrate methods of referencing the pulse output so that the transistor will be back-biased in the quiescent state.

2.3.7.1 Decoupling Output for Non-Linear Loads: When minimal pulse distortion is required and the load is non-linear, it might be necessary to decouple the P906 from the load by means of an emitter follower. The transistor used for the emitter follower must have the following:

- The frequency response necessary to give the required rise and fall times.
- Low input capacitance to minimize pulse distortion.
- Sufficient gain to supply the current required by the load.
- Sufficient power and voltage required by the load.

The positive output should be decoupled by NPN transistors and the negative output should be decoupled by PNP transistors. The receiving end of the cable should be terminated directly into a 50Ω resistor and the emitter follower input connected to the cable by a 22Ω resistor. (see Figure 2-15). The

Figure 2-9.
Output of P906
through 5 ft. of
50Ω Coaxial
Cable, Termina-
ted at Receiving
End in 50Ω Load
with 4" of #22
Wire.

Sweep=20ns/cm
Vert.= 2v/cm

Figure 2-10.
P906 Output
through 5' of
93Ω Coaxial
Cable, Termina-
ted at Receiving
End with 50Ω
Load.

Sweep=50ns/cm
Vert.= 2v/cm

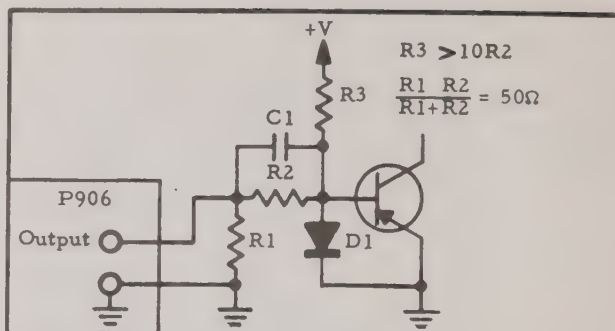
Figure 2-11.
P906 Output
through 5' of
50Ω Coaxial
(RG58) Cable,
Terminated in
100Ω Load.

Sweep=20ns/cm
Vert.= 2v/cm

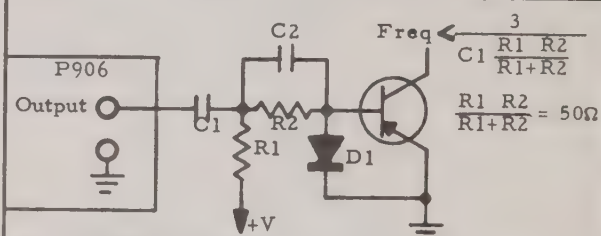
Figure 2-12.
Waveform at
Receiving End
of 6' 50Ω Coax.
Cable (RG58/U)
Terminated in
High Impedance
(10 meg shunted
by 3 pf).

Sweep=10ns/cm
Vert.= 5v/cm

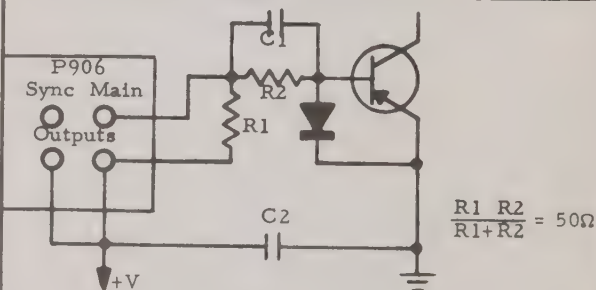
Figure 2-13.
Waveform at
Receiving End
of 6' of RG58U
Cable Termina-
ted in High
Impedance.



A. Resistor Coupling. $C1 \frac{R1 R2}{R1 + R2} > 10 \text{ Pulse Width}$



B. Capacitor Coupling



C. Referencing the P906 Output to a dc Voltage.

Figure 2-14. Connections for Driving
Non-Linear Loads

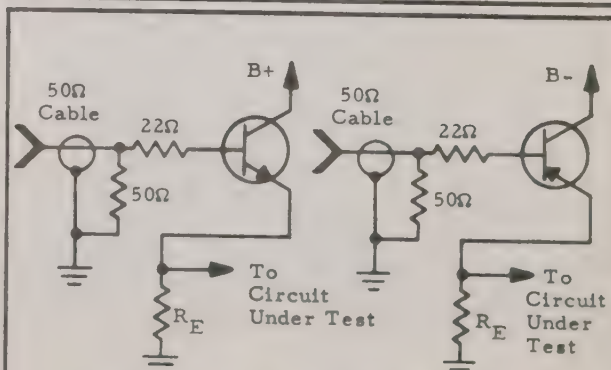


Figure 2-15. Decoupling Output for
Non-Linear Loads

resistor is used as a parasitic suppressor and is absolutely necessary to minimize pulse distortion at fast rise and fall times. The operating voltages and necessary resistors of the emitter follower are determined by the magnitude of voltage and current required by the load.

2.3.8 Mixing Outputs

2.3.8.1 Mixing Outputs of Several P906 Units: The outputs of several units may be mixed with each other in any combination of polarities if the common load is 50Ω . No damage will result regardless of the settings of the attenuator, polarity, or width controls; however, the loading effects of one P906 upon another P906 will cause severe distortion of the resultant waveforms. Figure 2-16 illustrates the effects of mixing the outputs of two P906 Units into a common 50Ω load.

Pulses of the same polarity may be mixed into a common 50Ω load with very little distortion if the Datapulse 2302 Mixer Unit is used. Figure 2-17 shows the mixing of two P906 Units for positive and negative pulses using the 2302 Mixer Unit. Very little additional distortion is introduced and the resultant rise and fall times are still less than 1.5 nanosec. If the 2302 Unit is not available, low distortion pulses can still be obtained by using a diode network as shown in Figure 2-18. The diode network is shown for positive pulses; for negative pulses, the diodes should be reversed.

2.3.8.2 Mixing P906 Outputs to Simulate High Repetition Rates: Two P906 Units can be combined to simulate a very high repetition rate. This is expedited if the units are used in conjunction with a Model 103 Pulse Generator which has two independent delay controls. By proper operation of the 103 delay controls, a two-pulse burst can be generated in which the spacing between the two pulses can be less than 1 nanosec. This is extremely useful in high speed testing such as finding the resolution time of flip flops, recovery time of amplifiers, response time of transistors, and other applications which require two events occurring within a period of nanoseconds in which the frequency of recurrence can be slow. Figure 2-19 illustrates two P906 Units being mixed to simulate a high repetition rate. In particular, the spacing between the pulses in Figure 2-19c simulates an effective repetition rate of 500 Mc.

2.3.8.3 Mixing P906 Output with Other Outputs: The P906 output can be mixed with other outputs provided:

- The baseline of the other output is at ground.
- The maximum amplitude of the other output is less than 10v.
- The common load resistor is 50Ω .
- A mixing network such as the 2302 or as shown in Figure 2-18 is used.

Mixing the P906 output with other outputs has the advantage of generating "oddball" pulse trains which can only be obtained in this manner. As an example, Figure 2-20 illustrates the result of mixing the outputs of a P905 and a P906. Figure 2-20c approximates a typical output at the sense line of a fast core or thin film memory. The first signal simulates noise from the digit drive and the second signal simulates the output from the core.

2.3.9 Obtaining Multipulses from the P906

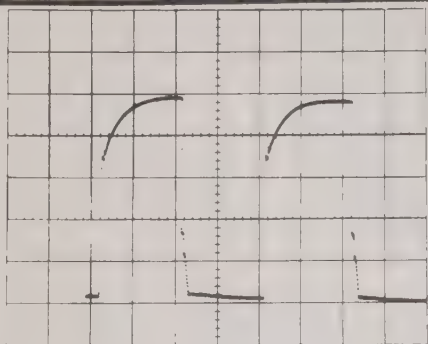
Multipulse bursts can be obtained from the P906 by using delay lines and a diode mixing network. Figure 2-21 shows a network for splitting and adding the output of the P906 to obtain a multipulse train. The output of the P906 is brought to a common point, A by a coaxial cable, L_1 , whose physical length is not critical. At point A, the signal is split into two paths by coaxial cables L_1 and L_2 . The original signal plus the signal from L_2 and L_3 is mixed to a common output by means of diodes D_1 , D_2 , and D_3 . The delay between the signals arriving at the output is determined by the length of L_2 and L_3 . If RG58/U cable is used, the delay will be approximately 1.5 nanosec per foot. It is important that the lengths of L_2 and L_3 be longer than the width of the input pulse to minimize distortion. However, the length should be less than 8 ft. in order to preserve a fast rise time and prevent ringing. Figure 2-22 illustrates a three-pulse burst from circuit shown in Figure 2-21.

Larger pulse trains can be obtained by adding more delay lines and diodes; however, this will tend to increase ringing and reduce the available pulse amplitude. By the use of this technique, effective burst rates in the hundreds of Mc region are readily obtained.

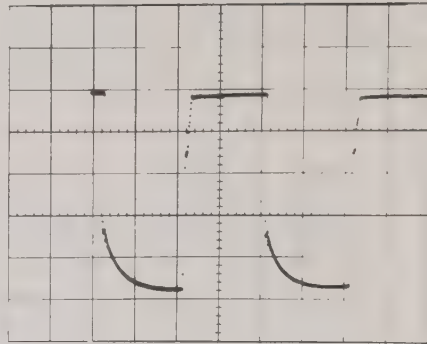
2.3.10 DC Level Shift of Output

For some applications, it is desirable to operate the P906 with the output baseline at some potential other than ground. Typical examples for this type of application are dc bias to hold active devices, either in the "on" or "off" state. The safest and simplest method of offsetting the baseline is to use capacitor coupling from the output of the P906 to the load. This is shown in Figure 2-23 for a positive level shift; for a negative level shift, the polarity of E_1 becomes negative. In order to preserve pulse fidelity, a wideband coupling capacitor, such as the General Radio 874-K coaxial capacitor, should be used. To minimize level shift as a function of frequency, the values of R_1 and R_2 should be kept small.

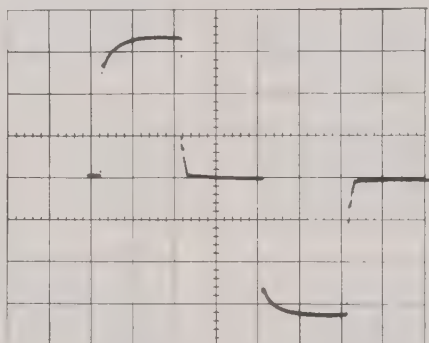
A dc current can be fed into the output of the P906 to shift its baseline. However, this will cause distortion of the pulse and the maximum value of the current must be kept below 80 ma. The current can be fed into the P906 by means of an external voltage and a resistor, as shown in Figure 2-24. The value of the resistor should be larger than 500Ω to approximate a current source. When the external current is 80 ma and the P906 is loaded into 50Ω , the bias level will be approximately 2v. The pulse distortion for this type of level shifting will increase as the current increases. Some distortion can be eliminated by adjustment of the front panel waveform controls. However, for most applications, it is advisable to use capacitor coupling to level shift the baseline.



A. 2 Positive Pulses with Common 50Ω Load

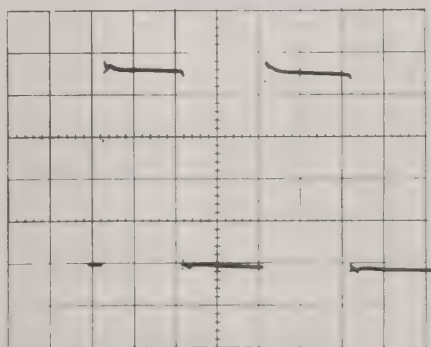
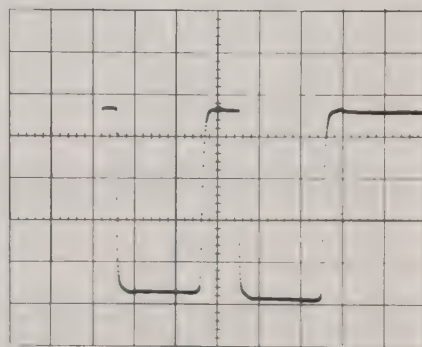


B. 2 Negative Pulses with Common 50Ω Load



C. Positive and Negative Pulses with Common 50Ω Load

Figure 2-16. Mixing Outputs of Two P906 Units.

A. 2 Positive Pulses
Sweep = 100ns/cm Vert. = 2v/cmB. 2 Negative Pulses
Sweep = 50ns/cm Vert. = 2v/cmFigure 2-17. Mixing Outputs of Two P906 Units into a Common 50Ω Load
by the Use of Datapulse 2302 Mixer Unit.

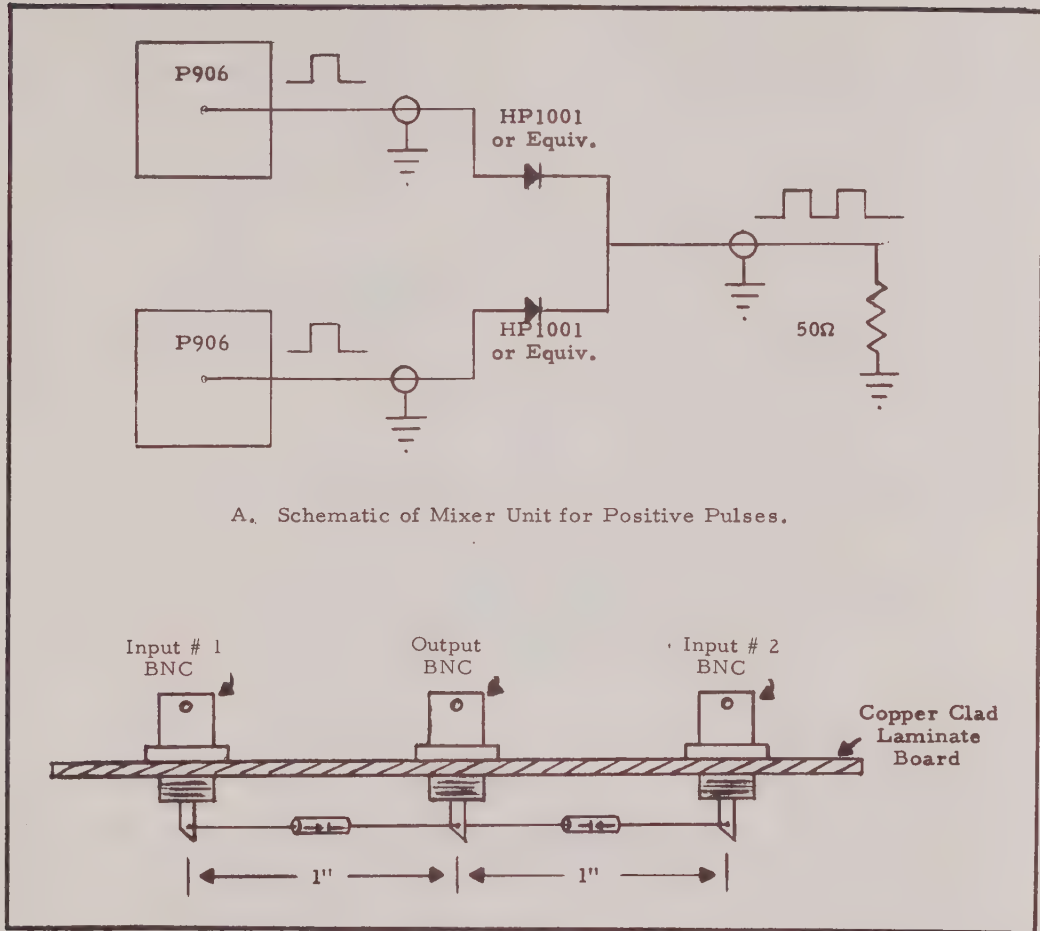
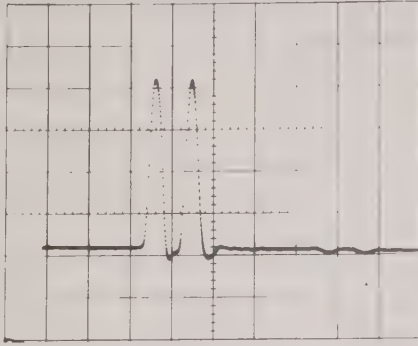
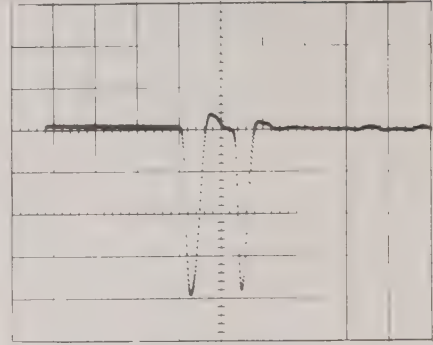


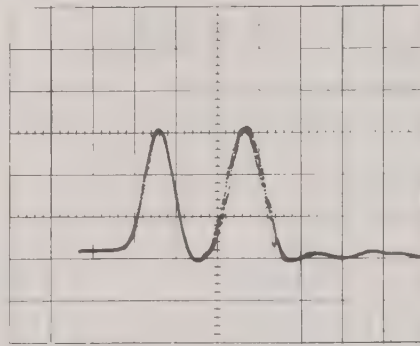
Figure 2-18. Mixer Unit for Mixing Two Positive Pulses.
Diodes Should be Reversed for
Negative Pulses.



A. Two Positive Pulses
Sweep = 5ns/cm Vert. = 2v/cm

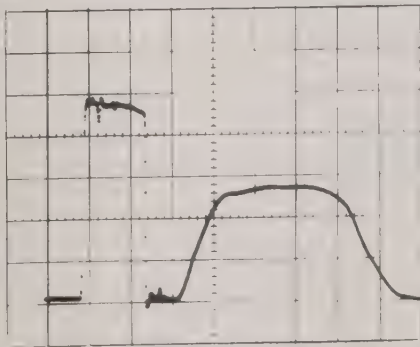


B. Two Negative Pulses
Sweep = 5ns/cm Vert. = 2v/cm

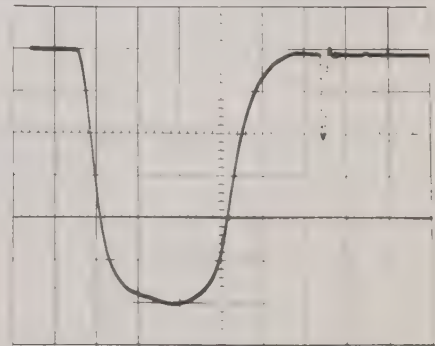


C. Two Positive Pulses
Sweep = 1ns/cm Vert. = 2v/cm

Figure 2-19. Mixing Two P906's into Common 50Ω Load Using Datapulse 2302 Mixer and Narrow Pulses.



A. First Pulse is P906 Output; Second Pulse is P905. Sweep = 20ns/cm, Vert. = 2v/cm



B. First Pulse is P905 Output; Second Pulse is P906 Output. Sweep = 20ns/cm, Vert. = 2v/cm

Figure 2-20. Mixing Outputs of P906 and P905 into Common 50Ω Load by Use of Datapulse 2302 Mixer Unit.

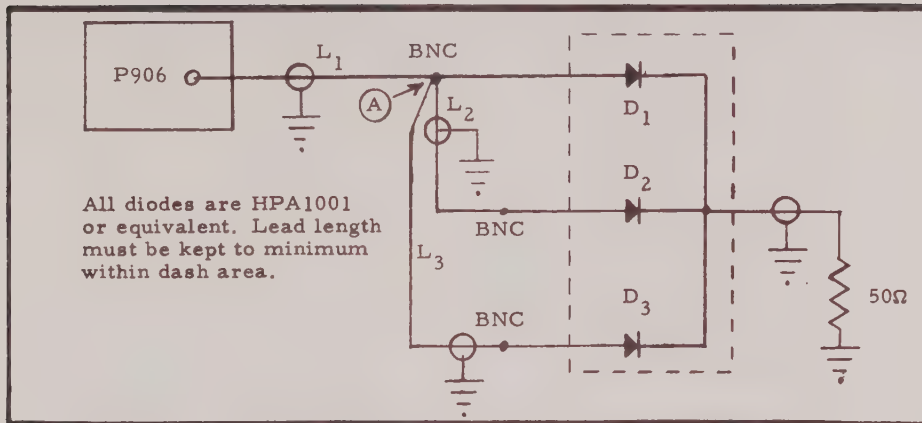


Figure 2-21. Network for Obtaining Multipulses from P906

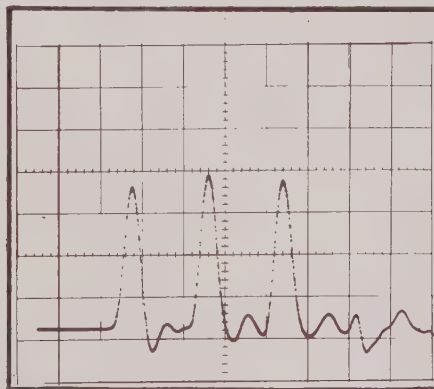


Figure 2-22. Three-Pulse Burst

Sweep = 5 ns/cm
Vert. = 2v/cm

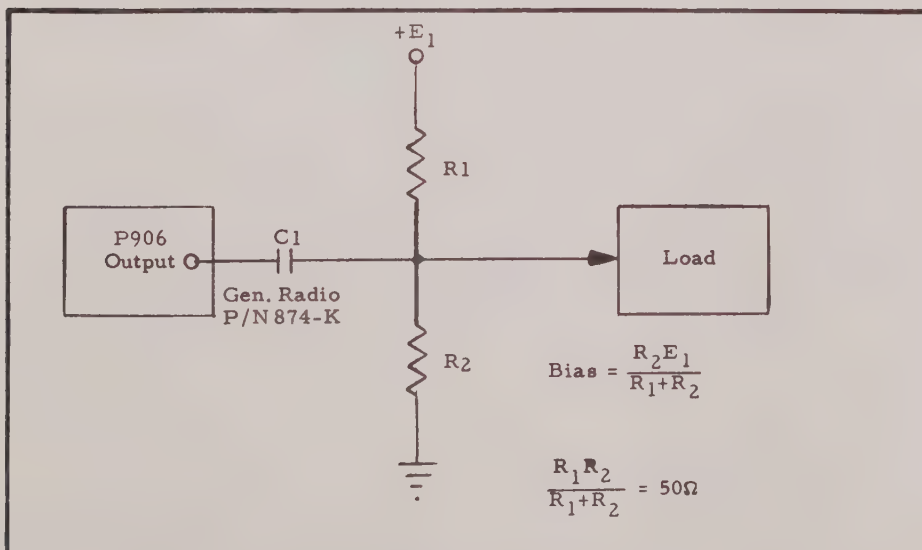


Figure 2-23. AC Coupling P906 Output to Load

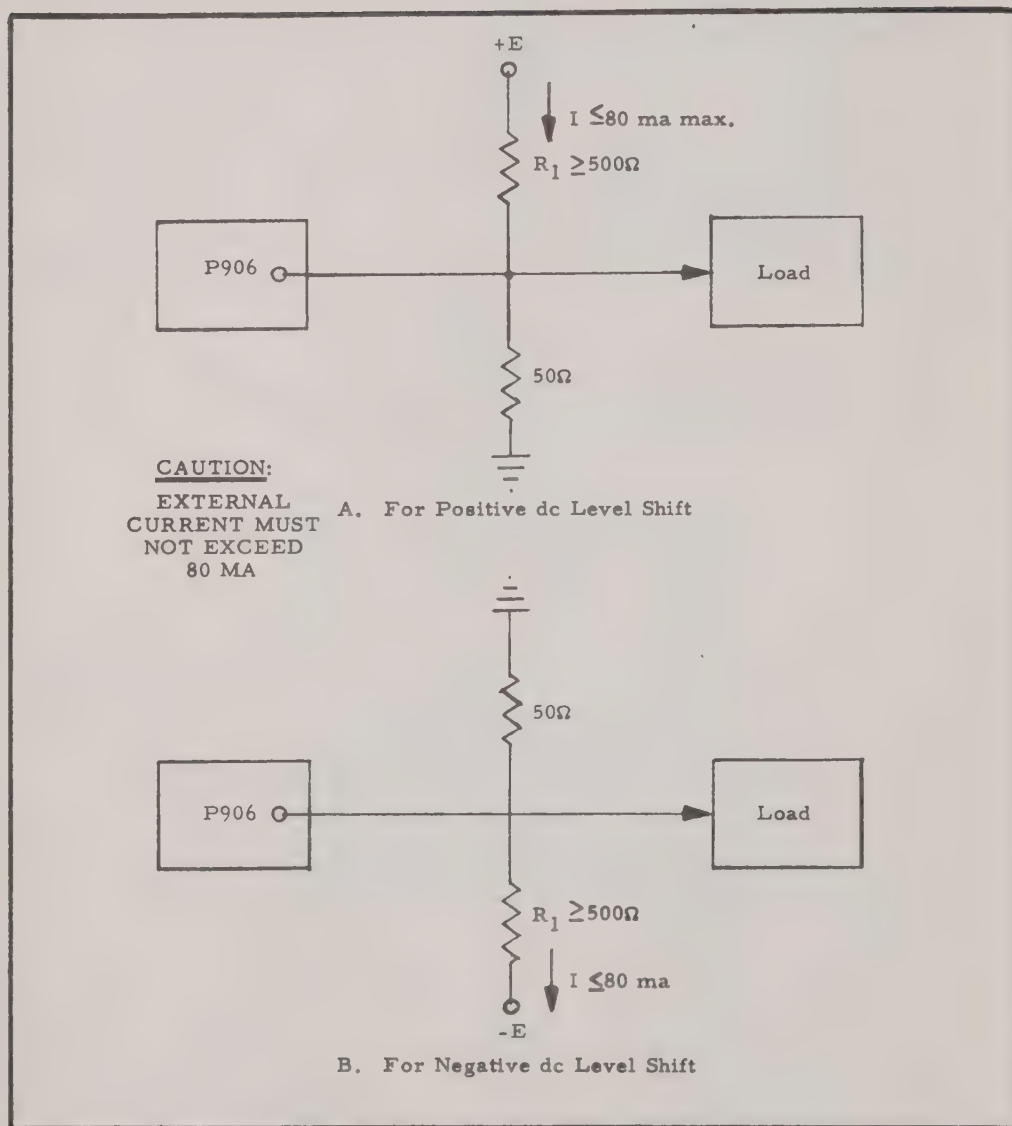


Figure 2-24. Level Shifting P906 Output by Feeding External dc Current

THEORY OF OPERATION

The P906 generates fast leading and trailing edges by charge storage, or "snap-off" diodes. This technique has the advantages of generating relatively high voltage pulses in the megacycle region, and still retaining high reliability. The output pulse is a composite of three separate portions:

- a. The leading edge
- b. The main portion
- c. The trailing edge.

The separate portions of the pulse are generated independently and are mixed through a diode network to form the output.

3.1 BLOCK DIAGRAM DESCRIPTION

The P906 input signal is derived from the parent pulse generator it is plugged in to. The timing circuits that generate pulse delay and pulse width are located in the P906. Figure 3-1 is a simplified block diagram showing the Polarity Switch in the negative pulse position. The input pulse triggers a blocking oscillator that standardizes the input triggers and limits maximum frequency of the input triggers to less than 2 Mc. The blocking oscillator output is used to generate the Start Pulse, Stop Pulse, and Sync Output Pulse. The Start Pulse is delayed from the input pulse by a 130 nanosec delay line. The delay between input and stop pulses is variable and is controlled by a one-shot multivibrator circuit. Because of this, the delay between Start Pulse and Stop Pulse also is controlled by the one-shot multivibrator; this constitutes the Width Control. In Figure 3-1, the Start Pulse is used to trigger the Negative Output Amplifier which is a power blocking oscillator with a natural period of approximately 300 nanosec. The output of the Negative Output Amplifier drives the snap-off diodes and mixing network. The Stop Pulse turns off the Negative Output Amplifier and turns on the Positive Output Amplifier which is also a power blocking oscillator. The output from the snap-off diode and mixing network is routed through a constant impedance attenuator to the output BNC connector.

The input pulse also drives a one-shot multivibrator circuit that controls the delay between Sync Output pulse and Start pulse. Since the Start pulse determines the Main Output occurrence, this controls the delay between Sync Output and Main Output.

For a positive pulse, the Polarity Switch is set to the + Pulse Output position; the Start pulse initially turns on the Positive Output Amplifier while the Stop pulse turns on the Negative Output Amplifier. Figure 3-2 is a timing diagram with idealized waveforms, showing the sequence of events for positive output. Photographs of the waveforms at different points of the block diagram are shown in Figure 3-3.

3.2 CIRCUIT DESCRIPTIONS

Refer to Drawing No. J40000-094 to follow the description of the Timing and Output Amplifier Circuits. Refer to Drawing No. J40000-093 to follow the description of the Power Supply Circuit.

3.2.1 Input Blocking Oscillator

The input pulse, from the parent pulse generator, is shaped and inverted by transistor Q1. The output of Q1 is coupled to the emitter of Q2. Q2 and Q3 form an emitter-coupled, blocking oscillator in which the emitter current of Q2 flows through the base of Q3. Positive feedback is coupled from the collector of Q2, back to its emitter, through T1. The output of Q3 is a positive pulse from -5v to 0v. This waveform is shown in Figure 3-3A. C4 and R7 form a time constant that prevents the circuit from triggering at rates above 1.5 Mc. This is necessary to protect the P906 from damage by excessive dissipation.

3.2.2 Fixed Delay Circuit

The output of Q3 turns on Q4 through a fixed 130 nanosec delay line. The waveform at the collector of Q4 is inverted and drives emitter follower, Q5. The output of Q5 forms the Start pulse which is positive going from 0v to +5v. The delay line is both source and load terminated by R20 and R21 to minimize reflections. R23 acts as a parasitic suppressor for Q5.

3.2.3 Variable Width Circuit

The output pulse width is controlled by a one-shot multivibrator comprising Q6, Q8, Q9, and Q10. In the quiescent state, Q6 is on and Q8 is off. The output of Q3 turns off Q6, causing its collector voltage to go negative. This causes Q8 to turn on and generates a positive going pulse at the collector of Q8. This signal is capacitor coupled to the base of emitter-follower, Q10, and the emitter output is fed back to the base of Q6, causing Q6 to remain off. Q9 is a current source which linearly charges C35. When C35 is fully charged, the signal at the base of Q10 drops to zero, allowing Q6 to turn on again and, thus, completing the cycle. The output width is determined by amount of time required to charge C35 and this is controlled by the value of the current flowing in Q9. The current magnitude is determined by the Width Control, R44.

The Q6 collector current flows through the primary of T30. The trailing edge of the pulse is inverted and turns on Q7. The positive going signal at the collector of Q7 is approximately 5v amplitude and is used as the Stop pulse.

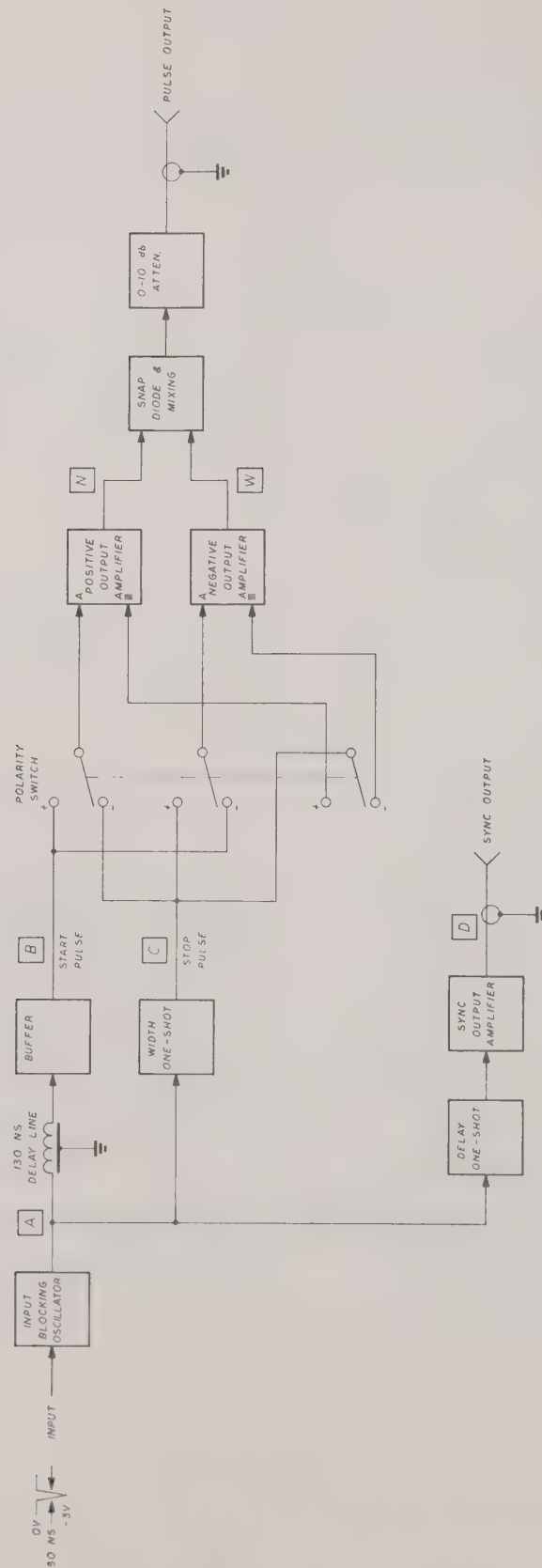


Figure 3-1. Simplified Block Diagram -- Model P906

1. POLARITY SWITCH SHOWN FOR NEGATIVE OUTPUT
 NOTES: UNLESS OTHERWISE SPECIFIED

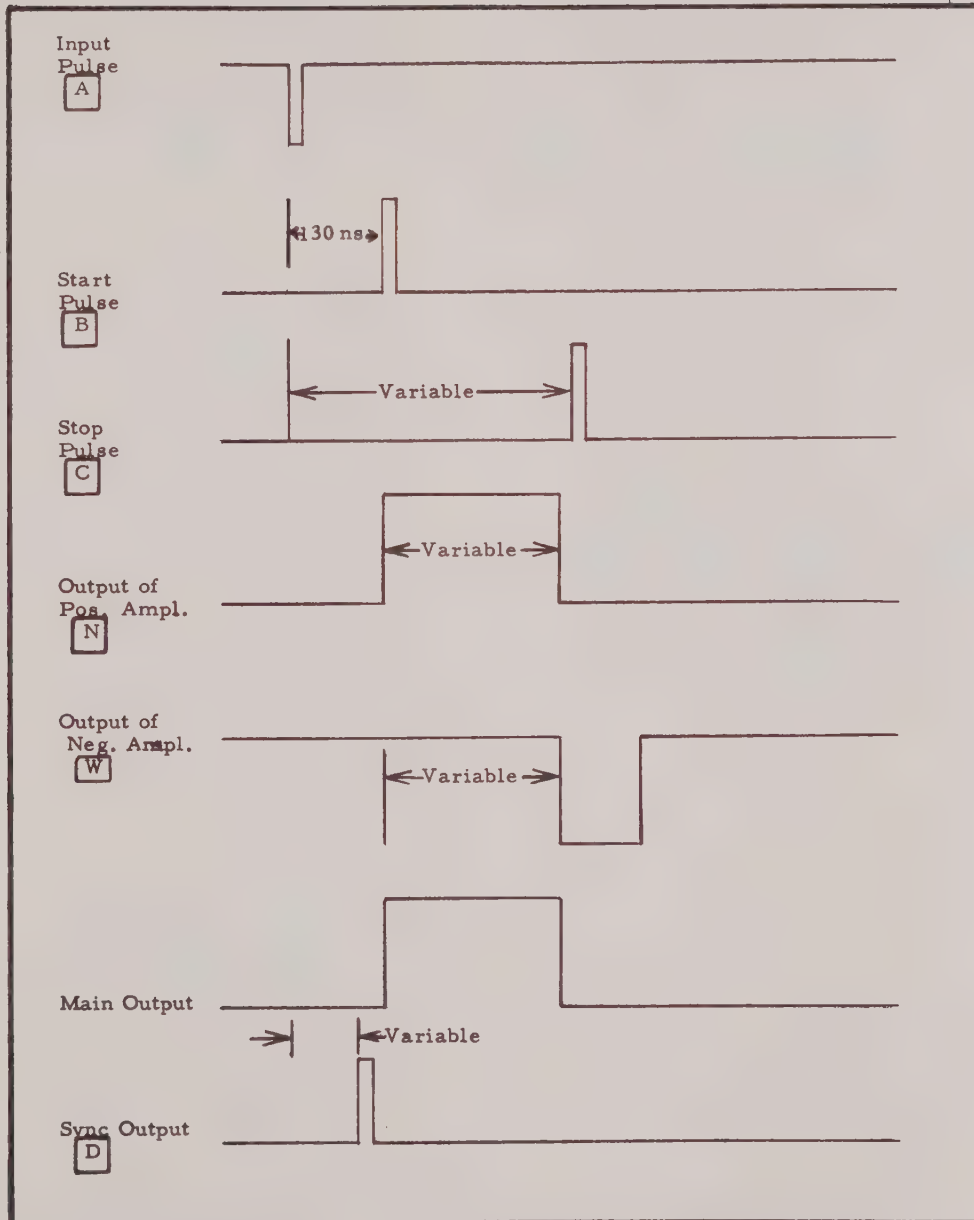
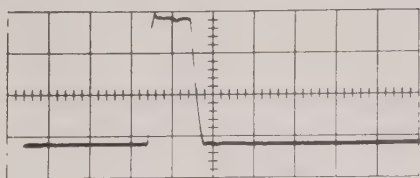
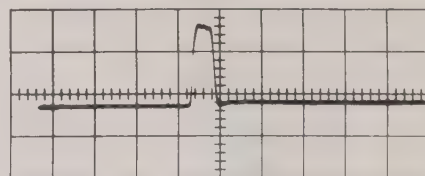


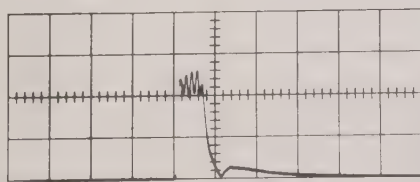
Figure 3-2. Timing Diagram for P906



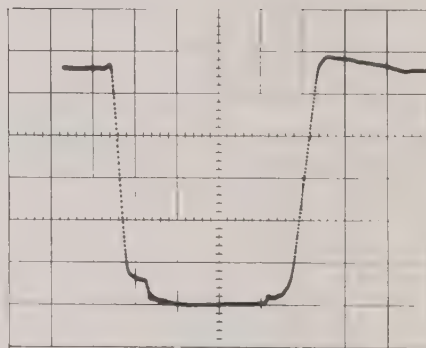
A. Waveform at Collector Q3 on Block Diagram.
Sweep = 50
Vert = 1v/cm



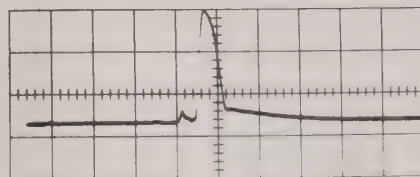
D. Waveform at Emitter of Q14 on Block Diagram.
Sweep = 0.2 μ s/cm
Vert = 2v/cm



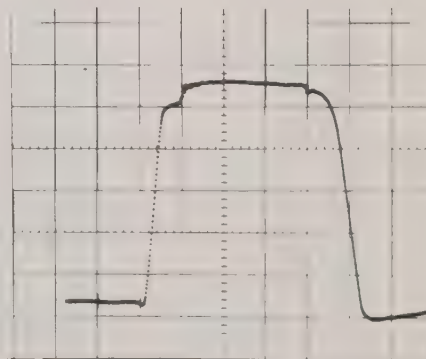
B. Waveform at Emitter of Q5 B on Block Diagram.
Sweep = 0.2 μ s/cm
Vert = 2v/cm



E. Waveform at Emitters of Q19 and Q20
N on Block Diagram.
Sweep = 50 ns/cm
Vert = 5v/cm



C. Waveform at Emitter of Q7 C on Block Diagram.
Sweep = 0.2 μ s/cm
Vert = 2v/cm



F. Waveform at Collectors of Q23 and Q24
W on Block Diagram.
Sweep = 50 ns/cm
Vert = 5v/cm

Figure 3-3. Waveform Photographs at Various Points of Block Diagram.

3.2.4 Variable Delay Circuit

The delay between Sync Output and Main Output is determined by a one-shot multivibrator comprising Q11, Q13, Q15, and Q16. The circuit operation is identical to that described for the variable width circuit.

The trailing edge of the signal at the collector of Q11 is inverted by T50 and used to turn on Q12. The output of Q12 is a positive pulse of 5v amplitude. This pulse is applied to the base of emitter follower, Q14, and the output of Q14 provides the Sync Output.

3.2.5 Output Section

The output section consists of the Positive Output Amplifier, Negative Output Amplifier, leading and trailing snap-off diodes, diode mixing network, and a 50 Ω constant impedance attenuator. The fast transition times of the P906 is made possible by the ability of the snap-off diodes to remain "on" when driven in the "off" direction and then to turn off abruptly. This abrupt transition from the "on" to "off" state forms the leading and trailing edges. Figure 3-4 is a simplified schematic of the output section showing a positive pulse output. In the quiescent state, snap-off diodes, D1 and D2, are forward biased by R1 and R2 respectively. The cathode of D1 is at -15v and the anode of D2 is at +16v, resulting in D3, D4, and D5 being reverse biased.

The Positive and Negative Output Amplifiers are power blocking oscillators with a natural period of 300 nanosec. The Start pulse turns on the positive output and the Positive Output Amplifier drives snap-off diode, D1, through inductor L1, toward the "off" direction. The stored charge of D1 causes D1 to remain on until the stored charge is depleted and it turns off abruptly. This causes the anode of D4 to rise rapidly from -15v to +15v. When the voltage rises above 0v, D4 is forward biased and the signal is passed to the output.

The output is terminated by application of the Stop pulse, causing the Positive Output Amplifier to turn off and the Negative Output Amplifier to turn on. The output of the Negative Output Amplifier drives snap-off diode, D2, in the "off" direction. D2 remains on until its stored charge is depleted and it turns off abruptly, causing a rapidly falling pulse, from +15v to -15v, to appear at the cathode of D3 and D3 turns on. D3 pulls the anode of D4 back to -15v and causes it to be reverse biased. At this point, the P906 output decreases abruptly to 0v. The negative pulse at the anode of D2 turns on D5 and this signal is applied to the primary of T1. The signal is inverted and fed back to the Stop input, B, of the Negative Output Amplifier, causing it to turn off, and completing the output cycle. This sequence of events is described graphically in Figure 3-5. The negative output cycle is identical except that the Negative Output Amplifier is turned on first.

3.2.5.1 Positive Output Amplifier: The Positive Output Amplifier is shown in Dwg. No. J40000-094. The circuit consists of the Blocking Oscillator, Q18, and the Power Amplifier, Q19 and Q20. A positive pulse at the input, A+, turns on Q18 and positive feedback, from the collector to the base through T301, allows Q18 to remain on. The signal is fed to the bootstrap amplifier, composed of Q19 and Q20 in parallel. This causes Q19 and Q20 to turn on and their emitter potential rises to +15v. The output of Q19 and Q20 is applied to snap-off diode, CR364. To turn off the cycle, a positive pulse is applied to Q17, turning on Q17 and causing the feedback signal at the base of Q18 to be shunted to -1v. At this point, Q18 turns off and the cycle is ended.

3.2.5.2 Negative Output Amplifier: The Negative Output Amplifier is shown in Dwg. No. J40000-094. The action of this circuit is identical to that of the Positive Output Amplifier except that the Power Amplifier, Q23 and Q24, is a conventional, grounded emitter stage. The negative going output, from +15v to -15v, is taken from the collectors of Q23 and Q24 and drives snap-off diode, CR366.

3.2.6 Power Supply

The P906 derives power from the parent pulse generator; however, to minimize pulse jitter and to maintain factory calibration, the voltages for the timing circuits and the output section is derived from within the P906. The circuits are shown in Dwg. No. J40000-093. These circuits are the conventional, feedback type amplifiers.

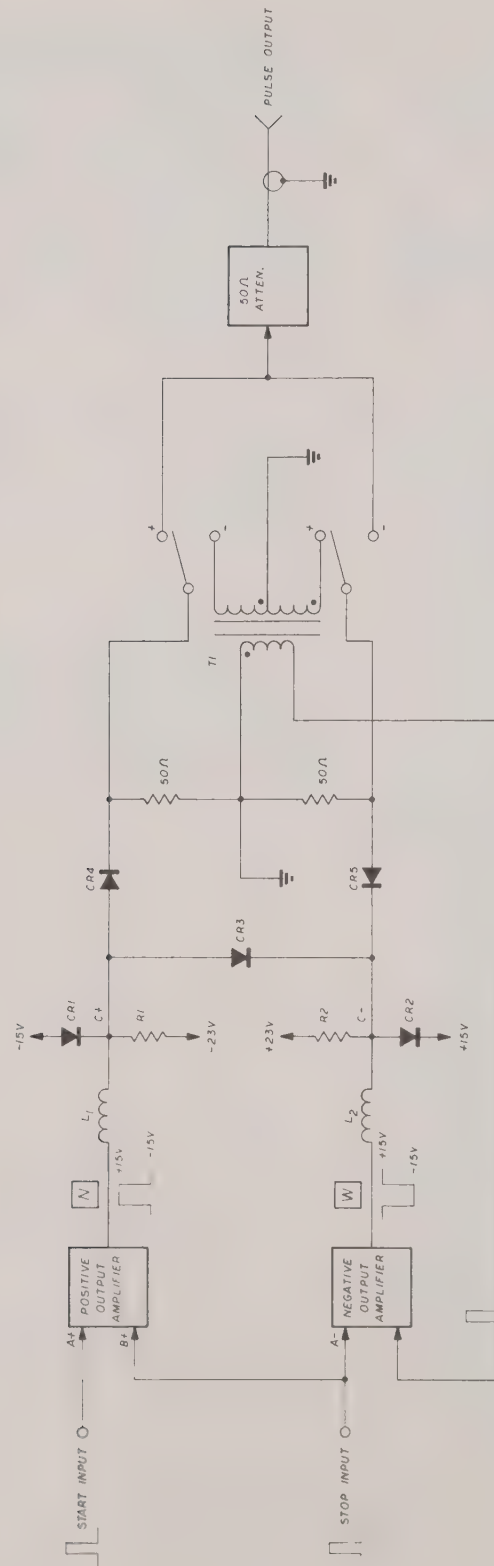


Figure 3-4. Model P906 Simplified Schematic

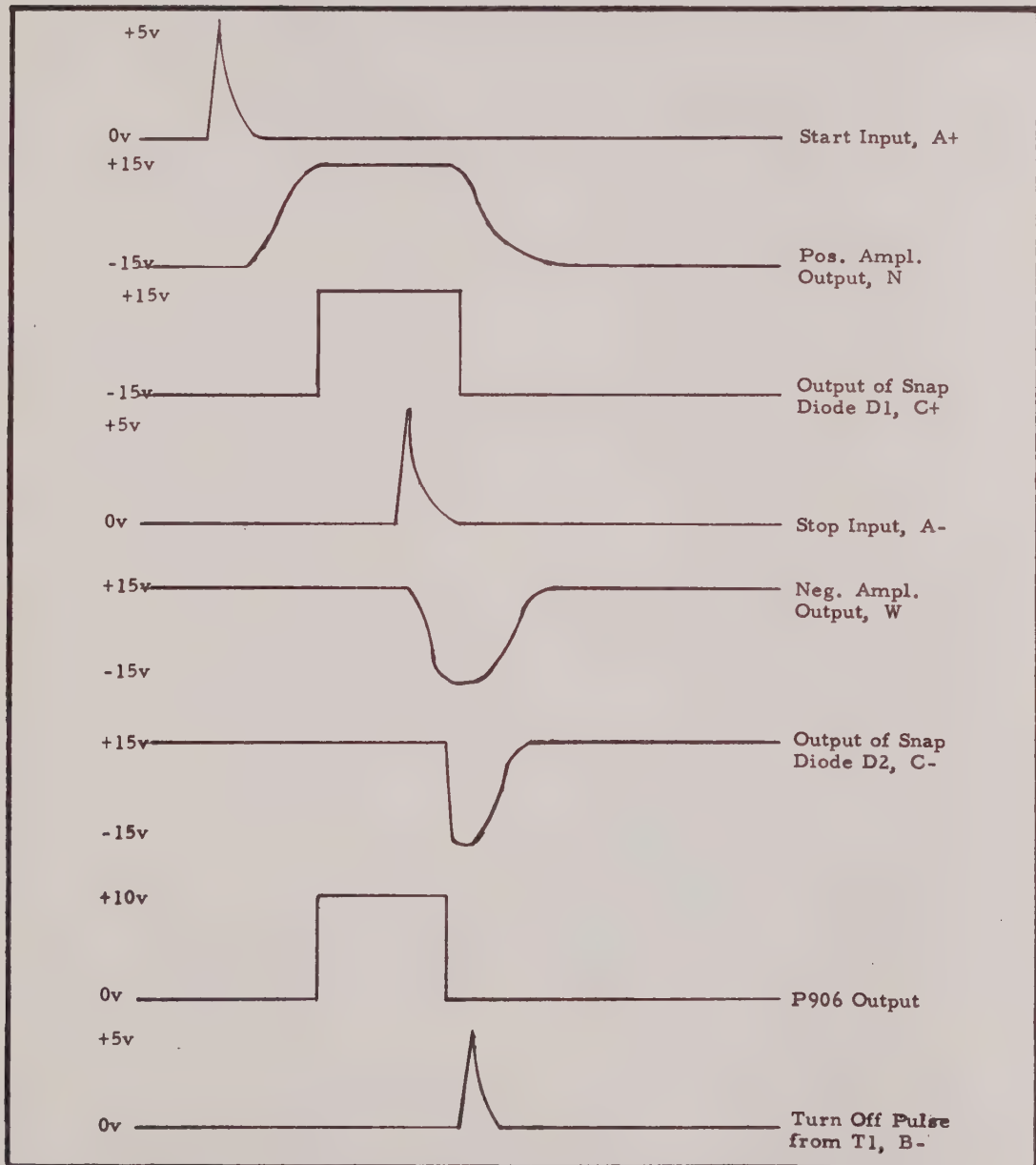


Figure 3-5. Timing Diagram of Output Section for Positive Output

MAINTENANCE INSTRUCTIONS

4.1 PREVENTATIVE MAINTENANCE**4.1.1 Preventative Inspection and Service**

Inspection and service of a preventive nature will result in optimum performance and longer life of this instrument. Dust covers should be removed at regularly scheduled intervals to permit inspection for dust, tarnish, corrosion, loose nuts and bolts (especially those serving as electrical conductors), loose cables and fuses, charred insulation, scorched resistors, and broken wiring. Discoloration of the printed circuit board, due to heat, does not affect the electrical properties of the board and may be disregarded in most cases.

4.1.2 Minor Repairs

The operator should be thoroughly acquainted with the instrument circuit theory and the location of components before attempting repair. All control settings and adjustments should be checked to verify that any difficulties encountered are caused by a malfunction, rather than by operating the instrument outside of specifications. Check the transistors in suspected circuits before conducting extensive tests upon other components. A check of important waveforms, as shown on the schematics, will be very helpful.

4.1.3 Recalibration

The P906 was designed to provide maximum reliability and stability. To insure that accuracy remains within the limits stated, the calibration should be checked after every 200 hours of operation. See Section 4.5 for calibration check. If the unit is used intermittently, the calibration should be checked every three months in accordance with the calibration instructions given in this manual.

4.2 PARTS REMOVAL AND REPLACEMENT**4.2.1 General**

This instrument is sturdily built and the components are easily accessible. Removal of most parts is so simple that explanations are unnecessary; however, some parts are removed more easily if a definite procedure is followed. Replacement of some parts will require partial recalibration.

4.2.2 Soldering Considerations

Although printed wiring is vulnerable to heat excesses, a great deal of resoldering can be done on a single joint, if care is taken. A 35-watt, wedge or pointed tip iron and 60-40 rosin core solder are effective. Where both sides of the board are accessible, apply the iron tip (on the side opposite the component) directly to the solder fillet and pull on the pigtail gently with pliers, from the opposite side. Where both sides of the circuit board are not accessible, the component lead will be fed into the board through an eyelet. Apply the iron tip to the eyelet and pull out the pigtail with pliers. To insert a new component, clean the hole with a sharp object, applying more heat if necessary, insert the new component into the hole, and solder.

4.3 TROUBLESHOOTING PROCEDURE

Before attempting any troubleshooting, check the front panel controls for proper setting. Refer to paragraph 2.3, "Operating Considerations", for instrument limitations and performance to be expected. After ascertaining that a trouble exists, continue according to the procedures outlined in this section.

Many apparent malfunctions are caused by improper calibration of one or more circuits and, often, a transistor is replaced that requires recalibration. If a circuit appears to be miscalibrated, refer to Section 4.4 for a detailed calibration procedure.

When a trouble occurs, test the power supply voltages in accordance with paragraph 4.4.2. The power supplies may be considered to function properly if the output and ripple voltages are correct.

When a malfunction can be attributed to a specific circuit, perform a complete visual inspection of that area. Visual inspection frequently reveals the effects (such as burned resistors) of the trouble, rather than the causes. However, these effects may give clues to the cause and it is important to find the real cause.

4.3.1 Troubleshooting the Power Supplies

Most power supply failures may be typified by collector to emitter shorts (transistors) and anode to cathode shorts (rectifiers and zener diodes). These conditions are easily detected "in circuit" with an ohmmeter because they measure very low resistance in both directions.

4.3.2 Troubleshooting the Pulse Circuits

After verifying that the power supplies function correctly, the most direct method of isolating a trouble is to begin at Test Point No. 1 and proceed through the instrument, comparing the waveforms with those listed in the schematic. This will generally narrow down the location of the trouble to one of a very few components. Because of the "straight through" nature of the instrument circuitry, most troubles will appear as either a complete absence of output pulses, or as an invariance of one or more pulse parameter. In the latter case, a good indication is given as to which circuit to suspect.

4.4 CALIBRATION PROCEDURE**4.4.1 Equipment Required**

- a. Tektronics Model 541 with CA plug-in or equivalent.
- b. Tektronics Model 661 with 451 plug-in or equivalent.
- c. Triplet Model 630 Multimeter or equivalent.
- d. Datapulse Model 103 Pulse Generator.
- e. Plug-in extension test cable.

MAINTENANCE INSTRUCTIONS

4.4.2 Procedure

4.4.2.1 Power Supply:

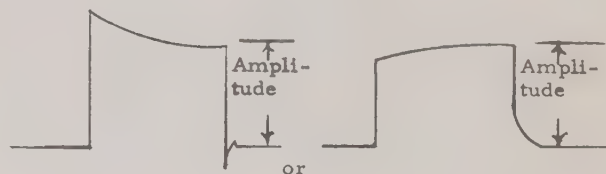
- a. Set Repetition Rate Control of Model 103 for 50 kc. Adjust $\pm 23\text{v}$ and $\pm 10\text{v}$ of Model 103 for correct reading.
- b. Connect P906 to Model 103 by extension cable.
- c. Set Polarity Switch to +Pulse Output.
- d. Put multimeter test leads on +15v Test Point. Adjust R505 for reading of +15v. Put multimeter test leads on -15v Test Point. Adjust R524 for reading of -15v.
- e. Set Polarity Switch to - Pulse Output.
- f. Put multimeter test leads on +15v Test Point. Adjust R504 for reading of +15v. Put multimeter test leads on -15v Test Point. Adjust R523 for reading of -15v.
- g. Put multimeter test leads on -5v Test Point. Adjust R542 for reading of -5v.

4.4.2.2 Timing Board:

- a. External trigger Model 541 with the Positive Sync Output of P906. Set Channels A and B of CA plug-in for 5v/cm. Set Polarity Switch of P906 to +Pulse Output and terminate Main Output with 50 Ω load. Put Channel A test probe on Test Point D of the timing board. Put Channel B test probe on Test Point A of the output amplifier board. Turn the P906 Delay Control to extreme counterclockwise position. Adjust "Delay U.L." Control (on timing board) so that the Channel B signal occurs approximately 10 nanosec before the Channel A signal. Turn P906 Delay Control to maximum clockwise position. Adjust "Delay L.L." Control so that Channel A signal appears 100 nanosec before Channel B signal. Repeat this procedure until the limits are correct.
- b. Trigger Model 661 Sampling Scope with Positive Sync Output of P906 attenuated 10:1. Feed Main Output of P906 to Channel A of 661 Scope with 10:1 attenuator at scope input. Set P906 Attenuator Control to 0 db position. Width Control to maximum cw. Adjust "Width U.L." Control (on timing board) so that output pulse is approximately 200 nanosec wide. Turn Width Control of P906 to maximum ccw and adjust "Width L.L." Control so that output pulse is approximately 2 nanosec wide. Repeat adjustments until limits are correct.

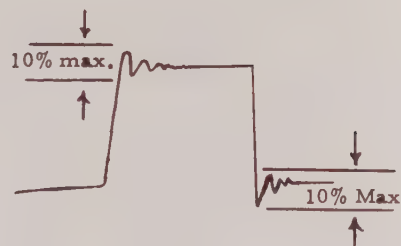
4.4.2.3 Output Amplifier Board:

- a. Set P906 controls as follows:
 Width -- 200 nanosec
 Delay -- 50 nanosec
 Attenuation -- 0 db
 Polarity -- Positive
 Waveform Adj -- Set both +Pulse and -Pulse adjustments to the midpoint.
- b. Trigger 661 Scope with Positive Sync Output of P906 through 10:1 attenuator; feed Main Output to Channel A of 661 Scope through 10:1 attenuator. Set Vertical Sensitivity of scope to 200 mv/cm. Output will appear on scope as follows:



- c. Adjust R505 (power supply board) so that pulse amplitude at trailing edge is 10v.
- d. Adjust R314 for maximum flatness of pulse flat top.
- e. Adjust R340 for minimum undershoot of pulse trailing edge and maximum flatness of baseline following trailing edge of pulse.
- f. Adjust C361 and C362 for minimum overshoot and distortion at leading edge of pulse.
- g. Set P906 Polarity Control to the - Pulse Output position.
- h. Adjust R523 for 10v amplitude as measured at pulse trailing edge.
- i. Adjust R341 for maximum flatness of pulse flat top.
- j. Adjust R315 for minimum undershoot at pulse trailing edge and maximum flatness of baseline following trailing edge of pulse.
- k. Adjust C370 and C371 for minimum overshoot and distortion at pulse leading edge.
- l. Repeat Steps c through k.
- m. Turn Attenuation Control through all positions. Each step of the control should attenuate the signal by 1 db (approximately 11% amplitude decrease). The pulse shape should remain the same regardless of the attenuator setting.

- n. Check Width Control. Width should vary from less than 2 nanosec to over 200 nanosec.
- o. Check Delay Control. Delay should vary from greater than -10 nanosec to greater than +100 nanosec.
- p. If the width and delay limits are off, repeat Paragraph 4.4.2.2 b of Timing Board Calibration.
- q. Check pulse distortion. The maximum distortion (overshoot and undershoot) should be less than 10% peak-to-peak.



- r. Check rise and fall times. Both should be less than 1 nanosec from the 10% amplitude point to the 90% amplitude point.

TABLE 4-1. VOLTAGE MEASUREMENT CHART

Tran-sistor	V _E	V _B	V _C	Tran-sistor	V _E	V _B	V _C	Tran-sistor	V _E	V _B	V _C
<u>Sw-Pos</u>				<u>Sw-Pos</u>				<u>Sw-Pos</u>			
Q501	+11.5	+12.0	+23.0	Q1	0	+0.55	-4.6	Q17	-0.68	-1.2	-0.7
Q502	+23.2	+23.0	+13.2	Q2	+0.45	+0.96	-9.8	Q18	+0.025	-0.7	+9.7
Q503	+12.5	+13.2	+21.6	Q3	0	+0.6	-5.7	Q19	-14.3	-14.3	+12.5
Q504	-12.7	-13.2	-22.0	Q4	-5.1	-5.5	0	Q20	-14.3	-14.3	+12.5
Q505	-22.6	-22.0	14.6	Q5	+0.15	0	+9.6	<u>Sw-Neg</u>			
Q506	-14.0	-14.7	-20.7	Q6	0	-0.43	-0.33	Q21	-0.68	-1.2	-0.7
Q507	-5/6	-4.9	-0.15	Q7	0	0	-4.9	Q22	+0.025	-0.7	+9.7
Q508	0	-0.15	-4.45	Q8	0	+0.42	-5.55	Q23	-12.0	-12.0	+15.6
Q509	-5.1	-4.45	-0.86	Q9	-2.6	-1.75	-0.55	Q24	-12.0	-12.0	+15.6
<u>Sw-Neg</u>				Q10	-1.17	-0.56	+9.6	<u>Sw-Neg</u>			
Q501	+13.5	+14.0	+22.3	Q11	0	-0.47	-0.29	Q17	-0.68	-1.19	-0.7
Q502	+22.8	+22.3	+15.7	Q12	0	0	-4.9	Q18	+0.025	-0.7	+9.8
Q503	+15.1	+15.7	20.8	Q13	0	+0.43	-5.6	Q19	-12.5	-12.5	+15.0
Q504	-11.0	-11.5	-22.1	Q14	-4.3	-4.9	0	Q20	-12.5	-12.5	+15.0
Q505	-22.7	-22.1	-12.8	Q15	-2.36	-1.52	-0.56	<u>Sw-Pos</u>			
Q506	-12.1	-12.8	-21.0	Q16	-1.17	-0.56	+9.6	Q21	-0.68	-1.18	-0.69
Q507	-5.6	-4.9	-0.14					Q22	+0.020	-0.7	+9.7
Q508	0	-0.14	-4.45					Q23	-14.0	-14.0	+13.1
Q509	-5.1	-4.45	-0.87					Q24	-14.0	-14.0	+13.1

PARTS LIST

5.1 HOW TO USE THIS PARTS LIST

5.1.1 Reference Designations

Reference designations used throughout this listing correspond with those given on component location photos and the following schematics:

Drawing No. 40000-093

Drawing No. 40000-094

Resistors are designated R1, R2, R3, etc., and are fixed value, composition, 10%, and 1/2w unless otherwise specified.

Capacitors are designated C1, C2, C3, etc., and are fixed value, 10%, 500v dc unless otherwise specified.

Diodes are designated as CR1, CR2, CR3; switches as S1, S2, S3; inductors as L1, L2, L3; and transistors as Q1, Q2, Q3, etc.

5.1.2 Abbreviations

The following abbreviations are used:

CER -Ceramic

DPC	-Deposited Carbon
ELECT	-Electrolytic
M	-Mica
MP	-Metalized Paper
GMV	-Guaranteed Min. Value
OF	-Oil Filled
PT	-Paper Tubular
SM	-Silver Mica
VAR	-Variable
WW	-Wire Wound
VTQ	-Vitamin Q
PNP	-Positive-Negative-Positive
NPN	-Negative-Positive-Negative
μsec	-Microsecond
μf	-Microfarad
μh	-Microhenry
ns	-Nanosecond
ms	-Millisecond

5.1.3 Federal Manufacturers Code Numbers

Manufacturers of the components used in this instrument are referenced herein by Federal Supply Code Numbers as given in the October 1959 issue of Department of Defense Cataloging Handbook H4-1 and H4-2, available from the Armed Forces Supply Support Center, Washington, D.C.

PARTS LIST

5.2 RESISTORS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R1	3	2.7k, 1/4w, 5%	10010-272	01121	CB2725		
R2	3	10k, 1/4w, 5%	10010-103	01121	CB1035		
R3	7	3.3k, 1/4w, 5%	10010-332	01121	CB3325		
R4	3	3.9k, 1/4w, 5%	10010-392	01121	CB3925		
R5	6	470Ω, 1/4w, 5%	10010-471	01121	CB4715		
R6	1	330Ω, 1/4w, 5%	10010-331	01121	CB3315		
R7	1	18k, 1/4w, 5%	10010-183	01121	CB1825		
R8	4	1k, 1/4w, 5%	10010-102	01121	CB1025		
R9	1	4.7k, 1/4w, 5%	10010-472	01121	CB4725		
R10		Same as R8					
R11 through R19		Not Used					
R20	1	510Ω, 1/4w, 5%	10010-511	01121	CB5115		
R21		Same as R5					
R22	3	1.5k, 1/4w, 5%	10010-152	01121	CB1525		
R23		47 Ω	10010-470		AB4705		
R24	1	560Ω, 1/4w, 5%	10010-561	01121	CB5615		
R25 through R29		Not Used					
R30		Same as R2					
R31	11	2.2k, 1/4w, 5%	10010-222	01121	CB2225		
R32	2	8.2k, 1/4w, 5%	10010-822	01121	CB8225		
R33	2	470Ω, 5%	10011-471	01121	EB4715		
R34	2	390Ω, 1/4w, 5%	10010-391	01121	CB3915		
R35		Same as R31					
R36	4	820Ω, 1/4w, 5%	10010-821	01121	CB8215		
R37	2	22k, 1/4w, 5%	10010-223	01121	CB2235		
R38		Same as R36					
R39		Same as R5					
R40	4	2.5k, 2w, 30%	20240-252	71450	UPE-70		
R41		Same as R1					
R42		Same as R34					
R43		Same as R40					
R44	2	5k, 2w, Var. Comp.	20053-502	01121	SD502-A		
R45		Same as R23					
R46		Same as R4					
R47 through R49		Not Used					
R50		Same as R2					
R51		Same as R31					
R52		Same as R32					
R53		Same as R33					
R54		Same as R23					
R55		Same as R31					
R56		Same as R36					
R57		Same as R37					
R58		Same as R23					
R59		Same as R36					
R60		Same as R5					
R61		Not Used					
R62		Same as R40					
R63		Same as R1					
R64		Same as R8					
R65	3	270Ω, 1/4w, 5%	10010-271	01121	CB2715		
R66		Same as R40					
R67		Same as R44					
R68		Same as R23					
R69		Same as R4					
R70 through R299		Not Used					

PARTS LIST

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R300		Same as R3					
R301		Same as R22					
R302		Same as R31					
R303	2	15k, 1/4w, 5%	10010-153	01121	CB1535		
R304		Same as R65					
R305		Same as R5					
R306	2	68 Ω , 1/4w, 5%	10010-680	01121	CB6805		
R307	2	Factory selected components in testing.					
R308	5	47 Ω , 1/4w, 5%	10010-470	01121	CB6805		
R309		Same as R308					
R310	6	2.7 Ω , 5%	10010-279	01121	EB27G5		
R311		Same as R310					
R312	2	75 Ω , 3w, 5%	10754-750	07115	Type LPI-3		
R313	2	500 Ω , 2w, Var.Comp	20053-501	01121	SD501-A		
R314	4	500 Ω , 2w, 20%, Var. WW	10493-501	08984	Type HHH-2		
R315		Same as R314					

R316 through R329 Not Used

R330		Same as R3
R331		Same as R22
R332		Same as R31
R333		Same as R303
R334		Same as R65
R335		Same as R5
R336		Same as R306
R337		Same as R307
R338		Same as R308
R339		Same as R308
R340		Same as R314
R341		Same as R314
R342		Same as R313
R343		Same as R312
R344		Same as R310
R345		Same as R310

R346 through R359 Not Used

R360		Same as R310			
R361	9	220 Ω , 1/4w, 5%	10010-221	01121	CB2215
R362		Same as R361			
R363		Same as R361			
R364	6	100 Ω , 1/4w, 5%	10010-101	01121	CB1015
R365		Same as R364			
R366		Same as R361			
R367		Same as R310			
R368		Same as R364			
R369		Same as R364			
R370		Same as R364			
R371		Same as R364			
R372		Same as R361			
R373		Same as R361			
R374	2	51 Ω , 5%	10011-510	01121	EB5105
R375		Same as R374			

R376 through R500 Not Used

PARTS LIST

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
R501	2	6.8k, 1/4w, 5%	10010-682	01121	CB6825		
R502	4	5.6k, 1/4w, 5%	10010-562	01121	CB5625		
R503		Same as R502					
R504	4	10k, 0.2w, 30% Var. Comp.	20240-103	71450	UPE-70		
R505		Same as R504					
R506		Same as R3					
R507	2	27Ω, 3w, 5%, WW	10264-270	03615	4372		
R508		Same as R361					
R509		Same as R31					
R510	2	150Ω, 3w, 5%, WW	10264-151	03615			
R511 through R519 Not Used							
R520		Same as R501					
R521		Same as R502					
R522		Same as R502					
R523		Same as R504					
R524		Same as R504					
R525		Same as R3					
R526		Same as R507					
R527		Same as R361					
R528		Same as R31					
R529		Same as R510					
R530 through R539 Not Used							
R540		Same as R31					
R541		Same as R3					
R542	1	5k, 0.2w, 30%, Var. Comp.	20240-502	71450	UPE-70		
R543		Same as R3					
R544		Same as R31					
R545		Same as R8					
R546		Same as R308					
R547		Same as R361					
R548		Same as R31					
R549	1	680Ω, 5%	10011-681	01121	EB6815		
R550	1	100Ω, 10w, 5%	10305-101	06136	10F100WL		
R551	1	200Ω, 5w, 5%	10304-201	06136	5F200WL		

PARTS LIST

5.3 CAPACITORS

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C1	6	47pf, 5%, SM	11017-470	00853	RR1447		
C2		Not Used					
C3	26	0.05μf, 25v, Fxd. Cerm. Disc	11241-503	91674	5855		
C4		Same as C1					
C5		Same as C1					
C6 through C29		Not Used					
C30		Same as C1					
C31	2	15pf, 5%, SM	11017-150	00853	RR1415		
C32	4	0.1μf, 75v, Fxd. Cer. Disc	11242-104	71590	DDA-104		
C33	2	27pf, 5%, SM	11017-270	00853	RR1427		
C34		Same as C32					
C35	1	68pf, 5%, SM	11017-680	00853			
C36		Not Used					
C37		Same as C3					
C38 through C49		Not Used					
C50		Same as C1					
C51		Same as C31					
C52		Same as C32					
C53		Same as C3					
C54		Same as C33					
C55		Same as C3					
C56		Not Used					
C57		Same as C1					
C58		Same as C32					
C59		Same as C3					
C60 through C300		Not Used					
C301		Same as C3					
C302	2	150pf, 5%, SM	11017-151	00853	DR1410		
C303		Same as C3					
C304		Same as C3					
C305	2	470pf, 300v, 5%, SM	11015-471	00853	RR06347		
C306	6	1000pf, 100v, 5%, Fxd. Mica Dipped	11073-102	02799	DM15E102J		
C307		Same as C306					
C308		Same as C3					
C309		Same as C32					
C310		Same as C3					
C311		Same as C3					
C312		Not used					
C313		Same as C3					
C314 through C330		Not Used					
C331		Same as C3					
C332		Same as C302					
C333		Same as C3					
C334		Same as C3					
C335		Same as C305					
C336		Same as C306					
C337		Same as C306					

PARTS LIST

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
C338		Same as C3					
C339		Same as C32					
C340		Same as C3					
C341		Same as C3					
C342	1	10pf, 5%, SM	11017-100	00853	DR1410		
C343		Same as C3					
C344 through C359 Not Used							
C360		Same as C3					
C361	4	0.4-4pf, Var. Cerm.	11307-040		2470-1		
C362		Same as C361					
C363		Same as C3					
C364		Same as C3					
C365	1	500pf, Button, Mica	11369-000	91674	654-006501K		
C366		Same as C306					
C367		Same as C3					
C368		Same as C365					
C369		Same as C306					
C370		Same as C361					
C371		Same as C361					
C372	2	1.5pf, ± 0.25 pf, 600v, Fxd, Cer. Tubular, Type NPO	11268-155	91624	CC20-CK-1R5C		
C373		Same as C372					
C374 through C500 Not Used							
C501	8	100 μ f, 35v, Elect.	11162-107	Nashville	20-500BP100-35S85		
C502		Same as C3					
C503		Same as C501					
C504 through C519 Not Used							
C520		Same as C501					
C521		Same as C3					
C522		Same as C501					
C523 through C539 Not Used							
C540		Same as C501					
C541		Same as C3					
C542		Same as C501					
C543		Same as C501					
C544		Same as C501					

PARTS LIST

5.4 TRANSISTORS

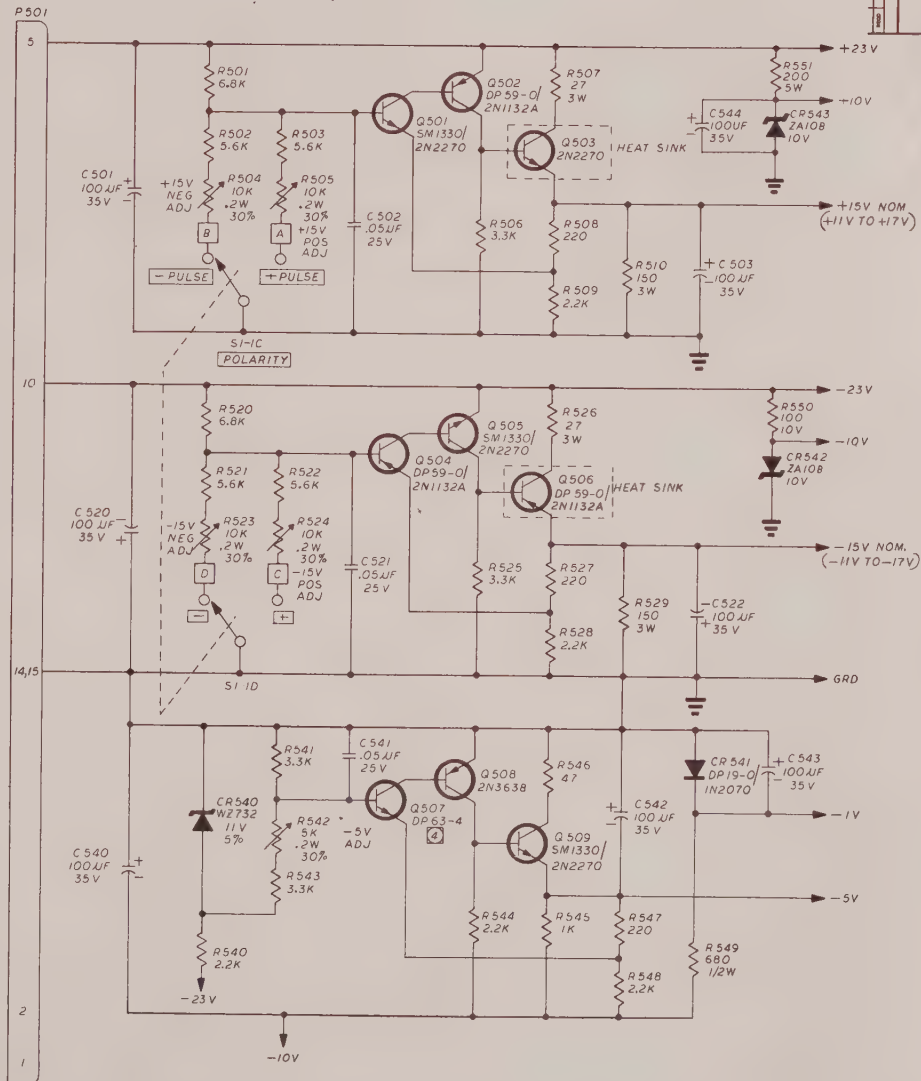
REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
Q1	8	Germ, PNP	22465-000	15933	DP46-0		
Q2	1	Germ, PNP	22605-001	94990	DP60-1		
Q3		Same as Q1					
Q4	11	Silicon, NPN	22635-004	15933	DP63-4		
Q5		Same as Q4					
Q6		Same as Q1					
Q7		Same as Q1					
Q8		Same as Q1					
Q9		Same as Q4					
Q10		Same as Q4					
Q11		Same as Q1					
Q12		Same as Q1					
Q13		Same as Q1					
Q14	4	Silicon, NPN	12685-004	94990	SM1330		
Q15		Same as Q4					
Q16		Same as Q4					
Q17		Same as Q4					
Q18		Same as Q4					
Q19	4	Silicon, NPN	12645-003	94990	2N2537		
Q20		Same as Q19					
Q21		Same as Q4					
Q22		Same as Q4					
Q23		Same as Q19					
Q24		Same as Q19					
Q25 through Q500 Not Used							
Q501		Same as Q14					
Q502	3	Silicon, PNP	22595-000	15933	DP59-0		
Q503	1	Silicon, NPN	12695-001	02735	2N2270		
Q504		Same as Q502					
Q505		Same as Q14					
Q506		Same as Q502					
Q507		Same as Q4					
Q508	1	Germ, PNP	12605-005	07263	2N3638		
Q509		Same as Q14					

PARTS LIST

5.5 DIODES

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	FEDERAL MFRS. CODE NO.	MFRS. PART NO.	REC. SPARES	UNIT PRICE
CR1	36	Silicon	22164-000	15933	DP16-0		
CR2		Same as CR1					
CR3		Same as CR1					
CR4		Same as CR1					
CR5		Same as CR1					
CR6		Same as CR1					
CR7 through CR29 Not Used							
CR30		Same as CR1					
CR31		Same as CR1					
CR32		Same as CR1					
CR33		Same as CR1					
CR34		Same as CR1					
CR35		Same as CR1					
CR36		Same as CR1					
CR37		Same as CR1					
CR38		Same as CR1					
CR39		Same as CR1					
CR40 through CR49 Not Used							
CR50		Same as CR1					
CR51		Same as CR1					
CR52		Same as CR1					
CR53		Same as CR1					
CR54		Same as CR1					
CR55		Same as CR1					
CR56		Same as CR1					
CR57		Same as CR1					
CR58		Same as CR1					
CR59		Same as CR1					
CR60 through CR300 Not Used							
CR301		Same as CR1					
CR302		Same as CR1					
CR303		Same as CR1					
CR304 through CR330 Not Used							
CR331		Same as CR1					
CR332		Same as CR1					
CR333		Same as CR1					
CR334 through CR359 Not Used							
CR360		Same as CR1					
CR361		Same as CR1					
CR362		Same as CR1					
CR363		Same as CR1					
CR364	2	Step Recovery Diode	12244-000		BA-0114		
CR365	3	Silicon, Planar, Epitax	12184-004		HPA1001		
CR366		Same as CR364					
CR367		Same as CR365					
CR368		Same as CR365					
CR369 through CR539 Not Used							
CR540	1	Silicon, Zener, 11v, 5%	12154-003		WZ732		
CR541	1	Silicon	22194-000	15933	DP19-0		
CR542	2	Zener, Silicon, 10v, 1w	12154-022	37942	ZA10B		
CR543		Same as CR542					

REVISIONS		DATE	BY	REASON
1	11	11	11	11
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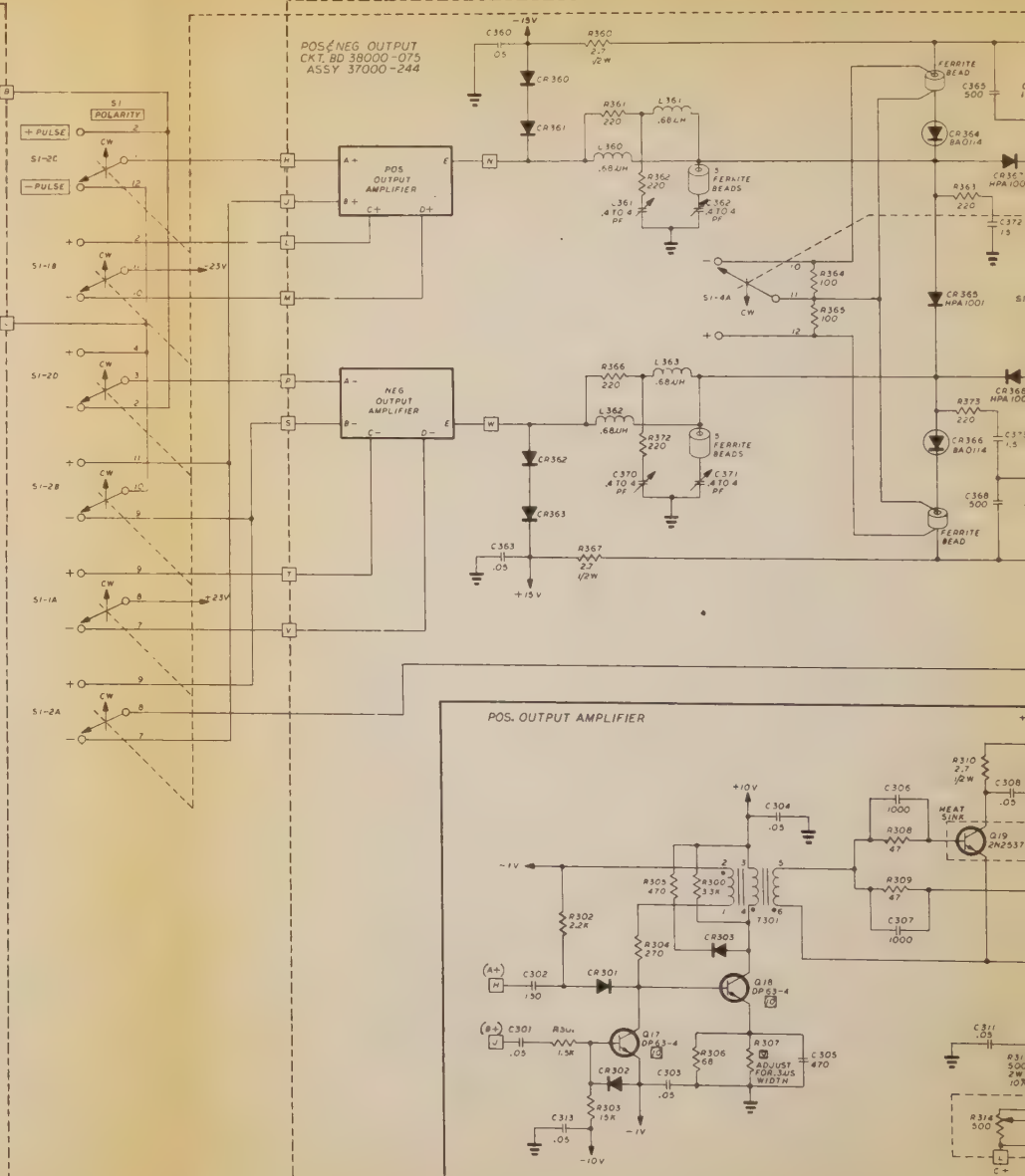
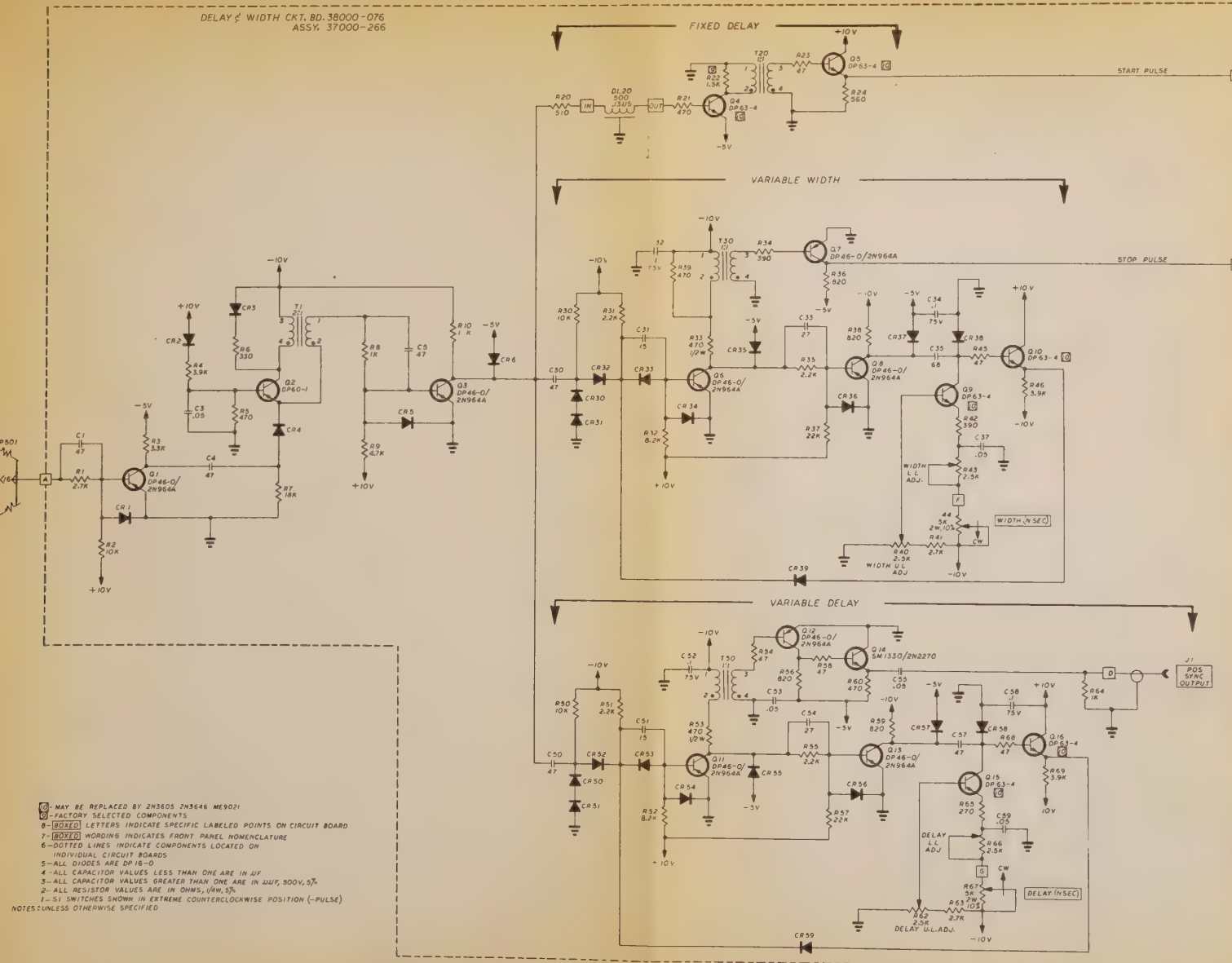
4 MAY BE REPLACED BY 2N3605, 2N3646, ME9021
 3-BOXED LETTERS INDICATE SPECIFIC LABELED POINTS ON CIRCUIT BOARD
 2-BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE
 1-ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%
 NOTES: UNLESS OTHERWISE SPECIFIED

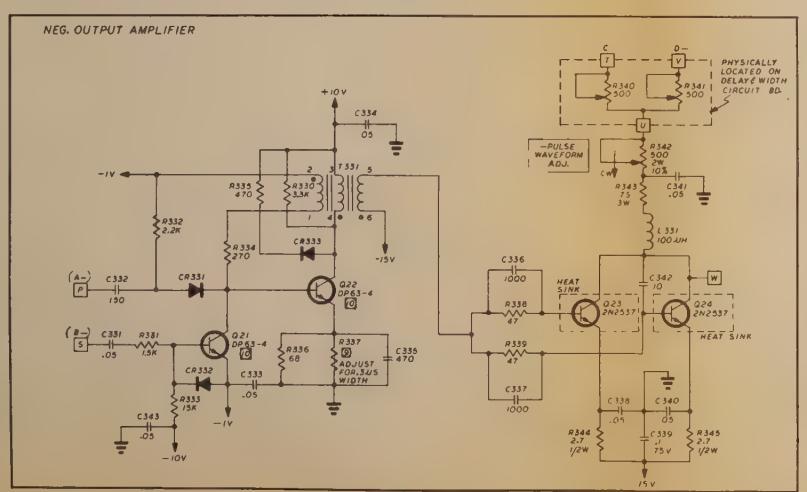
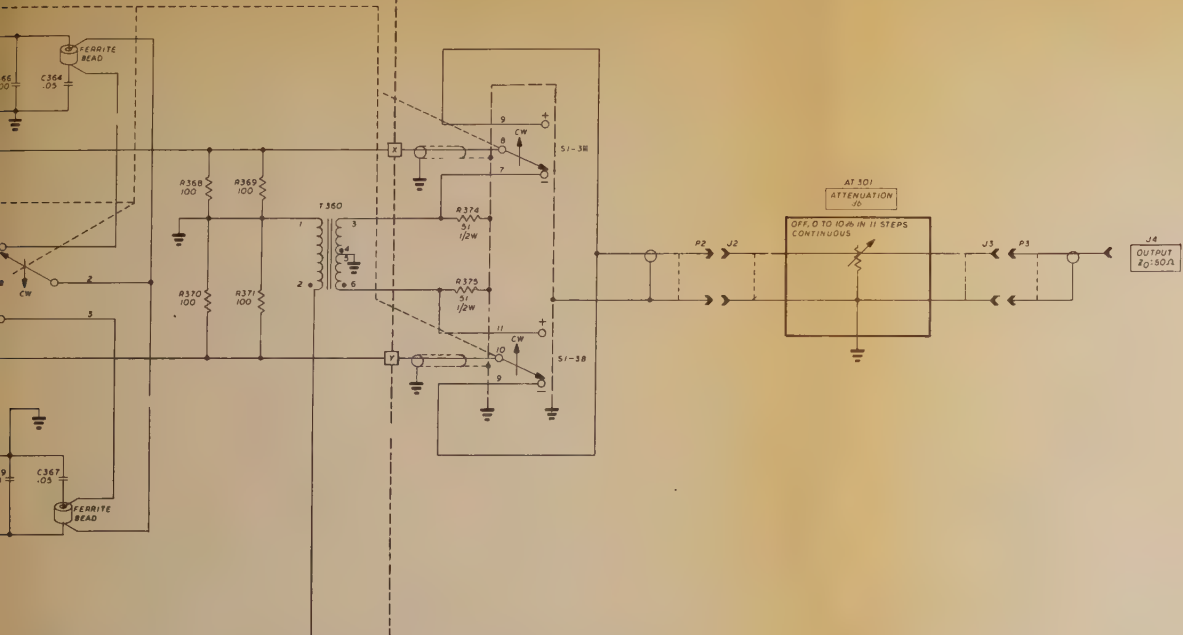
SCHEMATIC - POWER SUPPLY P 906		40000-093
Q501	Q509	Q501-539
CR540	CR543	CR501-539
C544	C504	C504-519,523-539
P501	R551	R511-519,530-539
FIRST USED		LAST USED
OMITTED		REFERENCE DESIGNATIONS

40000-093

1 1 1

DELAY & WIDTH CKT. BD. 38000-076
ASSY. 37000-266





DL 30	DL 30	
AT 301	AT 301	
L 363	L 363	L 302-330, 332-358
S 1	S 1	
D 1	D 24	
T 1	T 360	T 2-19, 21-29, 31-49, 51-300
CR 1	CR 368	CR 7-29, 40-49, 60-300
CI	C 373	104-350, 354-359, 369, 359
DI	R 375	C 25-29, 30, 39-49, 56, 60-300,
		312, 314-350, 344-359
		P 11-19, 25-29, 47-49, 61,
		70-299, 318-329, 344-359
		OMITTED

DL 30	DL 30	
AT 301	AT 301	
L 363	L 363	L 302-330, 332-358
S 1	S 1	
D 1	D 24	
T 1	T 360	T 2-19, 21-29, 31-49, 51-300
CR 1	CR 368	CR 7-29, 40-49, 60-300
CI	C 373	C 25-29, 30, 39-49, 56, 60-300,
DI	R 375	312, 314-350, 344-359
		P 11-19, 25-29, 47-49, 61,
		70-299, 318-329, 344-359
		OMITTED

DL 30	DL 30	
AT 301	AT 301	
L 363	L 363	L 302-330, 332-358
S 1	S 1	
D 1	D 24	
T 1	T 360	T 2-19, 21-29, 31-49, 51-300
CR 1	CR 368	CR 7-29, 40-49, 60-300
CI	C 373	C 25-29, 30, 39-49, 56, 60-300,
DI	R 375	312, 314-350, 344-359
		P 11-19, 25-29, 47-49, 61,
		70-299, 318-329, 344-359
		OMITTED

40000-094

ADDENDA AND ERRATA

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
2021	8-26-66	Transistor Equiv.	SM 1330, P/N 12685-004 is an acceptable substitute for DP63-6, P/N 22635-006.
2081	8-26-66	Transistor Substitution	2N2102, P/N 12685-005 may be used in lieu of 2N2270, P/N 12695-001.
2099	9-13-66		Change calibration procedure from -5 volts to -6 volts.
2352	10-10-67	J40000-094A L/M37000-266	Schematic - Output Amplifier 1. Change Q1, 3, 6, 7, 8, 11, 12 & 13 from DP46-0 P/N 22465-000 to DP46-1 P/N 22465-001.
2367	11-13-67	SB 1-65	Transistor 2N2369A P/N 22635-003 is an acceptable substitute for DP 63-4 P/N 22635-004.
2359	11-18-67	SB 1-65	NPN Transistor equivalent: RCA 38880 is an acceptable equivalent for RCA 40250.
2590	10-4-68	Manual	Pg. 5-6, Parts List: Change Capacitor - Button Mica (C365, 368) from 11369-000 to P/N 11369-501.
2668	1-27-69	40000-094	Schematic - Output Amplifier Add an 82 pF Dip Mica, P/N 11077-820 from the <u>OUT</u> of Delay Line DL20 to Ground. Add note <u>9</u> to this capacitor.
2684	2-25-69	40000-094	Schematic - Output Amplifier - Change Q19, 20, 23, and 24 from 2N2537 P/N 12645-003 to 2N3723, P/N 12635-001.
2704	4-4-69	Manual	Section 5.5 Diodes, Page 5-8, Item CR364 HP #5082-0202 (DP Part Number 12244-00) is an acceptable substitute.
3017	6-28-70	40000-094	Change DL20 from 130 ns, 500Ω to 140 ns, 500 ohm.
3213	11-23-70	40000-094	All DP601, P/N22605-001/0 may be substituted with DP608, P/N22605-008/0.

SEMICONDUCTOR REPLACEMENTS

DATAPULSE
DIVISION

(Applicable to all Datapulse Models
except the Model 102).

FROM



SERVICE BULLETIN NO. 1-65
Revised 2-19-70

The listed commercial equivalent diodes and transistors are suitable replacements for the corresponding Datapulse parts, either as direct substitutes, or as selected for the special performance characteristics given.

<u>DATAPULSE TYPE NO.</u>	<u>DATAPULSE PART NO.</u>	<u>COMMERCIAL EQUIVALENT</u>
<u>Diodes:</u>		
DP15-0	22154-000	1N752A selected for $\Delta V < 0.2V$ between 7mA and 110mA.
DP15-1	22154-001	Same as DP15-0 but matched in pairs to within 0.1V.
DP15-201	22154-201	1N936 selected for $9.4V \pm 0.1V$ @25mA.
DP16-0	22164-000	1N3600
DP16-1	22164-001	1N3604
DP16-2	22164-002	HPA1003
DP19-0	22194-000	1N2070 / 1N4005
DP19-1	22194-001	1N4002
DP19-6	22194-006	1N2071 / 1N4005
<u>Transistors:</u>		
DP43-0	22435-000	2N984
DP46-0	22465-000	2N2964A
DP46-1	22465-001	Selected for $h_{fe} = 100$ min.
DP59-0	22595-000	2N2904A
DP60-0	22605-000	2N2411
DP60-1	22605-001	2N2894 selected for $V_{ceo} (sust) =$ 20V min.
DP60-2	22605-002	2N2904 or 2N3133
DP60-3	22605-003	2N2894
DP60-4	22605-004	2N3209
DP60-5	22605-005	FT1702
DP60-6	22605-006	2N3640
DP60-7	22605-007	2N2894 selected for $V_{ceo} (sust) =$ 25V.
DP63-0	22635-000	2N2369 or 2N2501
DP63-1	22635-001	2N3723
DP63-2	22635-002	Replaced by DP63-3
DP63-3	22635-003	2N2369A (Fairchild)
DP63-4	22635-004	2N3646 or 2N2369A
DP63-6	22635-006	2N2270
DP63-7	22635-007	2N3261 selected for C_{OB} of 3.3pF or less
DP63-8	22635-008	May be replaced by 2N5109 selected for $h_{fe} \geq 20$ @ $I_C = 0.25A$ & $V_C = 2.5V$
DP63-9	22635-009	May be replaced by 2N5109 selected for $h_{fe} \geq 20$ @ $I_C = 0.25A$ & $V_C = 2.5V$
DP64-0	22645-000	May be replaced by 2N5109 selected for $h_{fe} \geq 20$ @ $I_C = 0.25A$ & $V_C = 2.5V$

DATAPULSE
DIVISION

SYSTRON  **DONNER**

CORPORATION

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WARRANTY

The Datapulse Division, Systron-Donner Corporation (hereinafter referred to as Datapulse) warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective.

Instruments returned under this Warranty will not be accepted at the Datapulse plant without prior authorization by a Datapulse representative or by the service manager of Datapulse.

Datapulse reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Datapulse and Datapulse neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Datapulse instruments.

MP MASTER



MA28917